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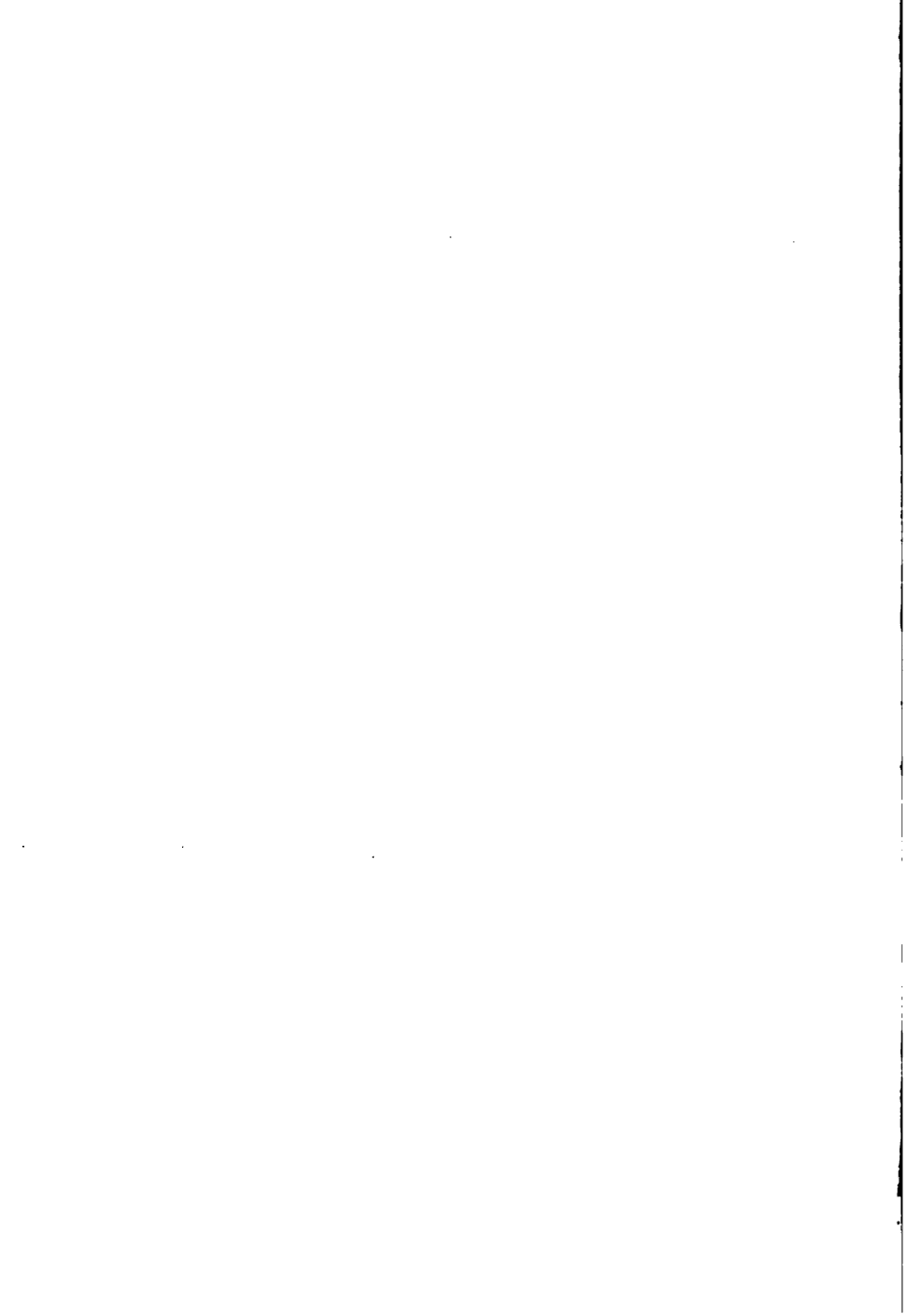
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The Badminton Library
OF
SPORTS AND PASTIMES

EDITED BY

ALFRED E. T. WATSON

MOTORS
AND
MOTOR-DRIVING



HER MAJESTY THE QUEEN IN HER ELECTRIC CAR
AT SANDRINGHAM

(After a photograph taken by H.R.H. Princess Victoria)

MOTORS AND MOTOR-DRIVING

BY

ALFRED C. HARMSWORTH

WITH CONTRIBUTIONS BY

THE MARQUIS DE CHASSELOUP-LAUBAT

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THE RIGHT HON. SIR J. H. A. MACDONALD

AND OTHERS



WITH ILLUSTRATIONS BY

H. M. BROCK, H. TRINGHAM, AND FROM PHOTOGRAPHS

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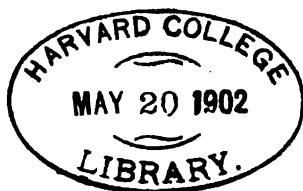
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BADMINTON

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A FEW LINES only are necessary to explain the object with which these volumes are put forth. At the time when the Badminton Library was started no modern encyclopædia existed to which the inexperienced man, who sought guidance in the practice of the various British Sports and Pastimes, could turn for information. Some books there were on Hunting, some on Racing, some on Lawn Tennis, some on Fishing, and so on ; but one Library, or succession of volumes, which treated of the Sports and Pastimes indulged in by Englishmen—and women—was wanting. The Badminton Library was produced to supply the want. Of the imperfections

which must be found in the execution of such a design we are conscious. Experts often differ. But this we may say, that those who are seeking for knowledge on any of the subjects dealt with will find the results of many years' experience written by men who are in every case adepts at the Sport or Pastime of which they write. It is to point the way to success to those who are ignorant of the sciences they aspire to master, and who have no friend to help, or coach them, that these volumes are written.

To those who have worked hard to place simply and clearly before the reader that which he will find within, the best thanks of the Editor are due. That it has been no slight labour to supervise all that has been written he must acknowledge ; but it has been a labour of love, and very much lightened by the courtesy of the Publisher, by the unflinching, indefatigable assistance of the Sub-Editor, and by the intelligent and able arrangement of each subject by the various writers, who are so thoroughly masters of the subjects of which they treat. The reward we all hope to reap is that our work may prove useful to this and future generations.

BEAUFORT.

P R E F A C E

IN a history of the origin and compilation of the BADMINTON LIBRARY prefaced to 'The Poetry of Sport,' I wrote, 'With this volume, the twenty-eighth of the series, the BADMINTON LIBRARY comes to an end, at least so far as is at present contemplated'; but noting how, since the issue of 'Hunting' in 1885, Golf and Cycling had attained such extraordinary prominence and popularity, I added, 'Who can say what sport may not spring up and take the public fancy? If any such does arise, a volume about it will doubtless be written.' Motoring—for the verb will have to be accepted and recognised—is such a sport, or, if the description be not admitted on all hands, is at any rate, for reasons set forth in the following chapters, sufficiently near to sport to require inclusion; and therefore no excuse seems necessary for this book. That automobilism is by no means a new idea the Marquis de Chasseloup-Laubat shows in his contribution; indeed,

he traces the origin of the movement to the year 1769, and gives a picture of a steam coach which ran daily from Paddington to Harrow as long ago as 1833. It is only within the last two or three years, however, that any sustained attempt has been made to introduce motor-cars into this country, and to employ them extensively as pleasure vehicles and for practical purposes.

The movement was exhibiting such vigour that a Badminton book became inevitable ; but it could scarcely have appeared so soon had it not been for the initiative and energy of an enthusiast, Mr. Alfred Harmsworth, one of the leading pioneers of automobilism in England, for whose invaluable assistance the Editor and Publishers cannot make sufficient acknowledgment. He is to a great extent responsible for the present volume, of the completeness of which it is not for us to speak, though we confidently anticipate the verdict of critics and of readers. The heartiest recognition must also be given to the untiring aid of Mr. Claude Johnson, Secretary of the Automobile Club, who has probably done more than any other man towards helping to rescue what must assuredly become a great British industry from foreign hands. Mr. Harmsworth and Mr. Johnson were fortunately able to secure the hearty co-operation of the Automobile Club. The

various chapters have been read before and exhaustively discussed by the members, to whom are due the thanks of the compilers and likewise of all who may benefit by the varied contents of the work ; nor must an expression of gratitude be omitted to the designers and makers of cars, English and foreign, who have so kindly furnished particulars, photographs and drawings.

As far as possible an endeavour has been made to avoid mentioning the names of particular constructors ; where such mention was unavoidable, it should not be understood as suggesting that in the opinion of the writer the cars manufactured by them are necessarily the best ; nor, on the other hand, must it be supposed that because various cars are not included, anything in the nature of adverse criticism is implied. The industry is being pursued with such great activity that to discuss every notable make and invention was impossible within the prescribed limits of the volume.

ALFRED E. T. WATSON.

April 1902

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MOTORS AND MOTOR-DRIVING

CHAPTER I

A SHORT HISTORY OF THE MOTOR-CAR

BY THE MARQUIS DE CHASSELOUP-LAUBAT

WHEN I was first invited to write a brief History of the Motor-Car, I at once realised that I could not do so without repeating much which was contained in an article entitled 'Recent Progress of Automobilmism in France,' which I wrote for the 'North American Review' in September 1899.¹

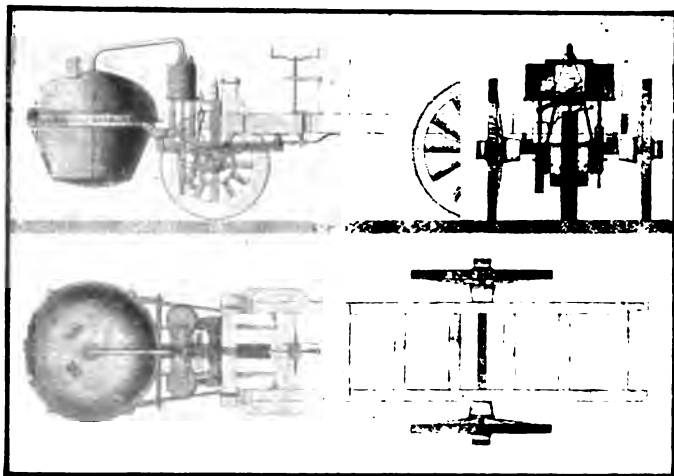
It is more than a century since, in 1769, automobilism was born in France, with the steam carriage of Cugnot. This vehicle was of a crude, rudimentary, and incomplete construction. The ideas of Cugnot were an entire century in advance of the mechanical means by which they could be realised.

The attempt led to no satisfactory results. Everything was defective—motive-power, steering, control. Nevertheless, the carriage ran, and ran so well, they say, that it broke down the enclosure of the ground on which it was tried. It is an incontestable fact that Cugnot is the inventor of automobile locomotion, and that the honour of first having imagined and realised a new method of transport, destined to play an important part in the welfare of many lands, belongs to him.

¹ The proprietors of that publication have been good enough to consent to my making use of portions of my article, and I take this opportunity of expressing my appreciation of their courtesy.

At the end of the eighteenth and the beginning of the nineteenth century, the great wars of American Independence, of the First Republic, and of the First Empire turned the spirit of France aside from new effort in the way of any kind of locomotion.

It was in England, towards the third decade of the nineteenth century, that we saw the idea of Cugnot reappear. The same impulse which moved English engineers to build railroads in



Elevation and Plan of N. J. Cugnot's Steam Car, 1770

order to free the great industrial centres from the economic tyranny of those who constructed canals, urged them to study methods of automobile locomotion on highways. That is to say, in its inception, automobile locomotion was considered as an auxiliary to the railroad, which it really is.

Unfortunately, the promoters of new railway lines did not at all understand the respective spheres of action of the machine on the rail and the machine on the road. They took umbrage at automobile locomotion, and, since they had much capital

and influence at their disposal, they secured a law from the English Parliament which effectually killed automobile locomotion. It ordained that a man carrying a red flag by day, or a red lantern by night, must be kept a hundred yards in advance of every automobile vehicle.

The report of the Select Committee of the House of Commons which was published in 1831 is extremely instructive, and contains the following remarkable paragraphs:—

These inquiries have led the Committee to believe that the substitution of inanimate for animal power, in draught on common



Hancock's Steam Coach 'Era,' 1833

roads, is one of the most important improvements in the means of internal communication ever introduced. Its practicability they consider to have been fully established; its general adoption will take place more or less rapidly, in proportion as the attention of scientific men shall be drawn by public encouragement to further improvements.

Many circumstances, however, must retard the general introduction of steam as a substitute for horse-power on roads. One very formidable obstacle will arise from the prejudices which always beset a new invention, especially one which will at first appear detrimental to the interests of so many individuals.

Tolls to an amount which would utterly prohibit the introduc-

tion of steam-carriages have been imposed on some roads ; on others, the trustees have adopted modes of apportioning the charge, which would be found, if not absolutely prohibitory, at least to place such carriages in a very unfair position as compared with ordinary coaches.

It appears from the evidence that the first extensive trial of steam as an agent in draught on common roads was that by Mr. Gurney, in 1829, who travelled from London to Bath and back in his steam-carriage.¹ He states that, although a part of the machinery which brings both the propelling wheels into action, when the full power of the engine is required, was broken at the onset, yet that on his return he performed the last eighty-four miles, from Melksham to Cranford Bridge, in ten hours, including stoppages.

The committee have also examined Messrs. Summers and Ogle, Mr. Hancock, and Mr. Stone, whose steam carriages have been in daily use for some months past on common roads.

Besides the carriages already described, Mr. Gurney has been informed that from twenty to forty others are being built by different persons, all of which have been occasioned by his decided journey in 1829.

Much, of course, must remain to be done in improving their efficiency ; yet Mr. Gurney states that he has kept up steadily the rate of twelve miles per hour ; that the extreme rate at which he has run is between twenty and thirty miles per hour.

Mr. Hancock reckons that with his carriage he could keep up a speed of ten miles per hour, without injury to the machine.

Mr. Ogle states : 'That his experimental carriage went from London to Southampton in some places at a velocity of from thirty-two to thirty-five miles per hour.

'That they have ascended a hill rising one in six at sixteen and a half miles per hour, and four miles of the London Road at the rate of twenty-four miles and a half per hour, loaded with people.

'That his engine is capable of carrying three tons weight in addition to its own.'

Mr. Summers adds : 'That they have travelled in the carriage

¹ The Gurney steam coach was extremely interesting. It possessed : (1) A water tube boiler analogous to the Thorneycroft boiler, in which the circulation was remarkable. (2) The pressure was considerable (5 kilos per sq. centimetre).

at the rate of fifteen miles per hour, with nineteen persons on the carriage up a hill one in twelve.

‘That he has continued for four hours and a half to travel at the rate of thirty miles per hour.

‘That he has found no difficulty in travelling over the worst and most hilly roads.’

Mr. James Stone states that ‘thirty-six persons have been carried on one steam-carriage.

‘That the engine drew five times its own weight nearly, at the rate of from five to six miles per hour, partly up an inclination.’



Squire and Macerone Steam Coach, 1833

Ran daily from Paddington to Edgware and Harrow. Average speed, fourteen miles per hour. Speed on level, twenty miles per hour. Cost of coke, 3*d.* to 4*d.* per mile.

They have annexed a list of those local acts in which tolls have been placed on steam, or mechanically propelled carriages.

Mr. Gurney has given the following specimens of the oppressive rates of tolls adopted in several of these acts. On the Liverpool and Prescott Road, Mr. Gurney's carriage would be charged 2*l.* 8*s.*, while a loaded stage coach would pay only 4*s.* On the Bathgate Road the same carriage would be charged 1*l.* 7*s.* 1*d.*, while a coach drawn by four horses would pay 5*s.* On the Ashburnham and Totnes Road, Mr. Gurney would have to pay 2*l.*,

while a coach drawn by four horses would be charged only 3s. On the Teignmouth and Dawlish Roads the proportion is 12s. to 2s.

The trustees of the Liverpool and Prescott Road have already obtained the sanction of the legislature to charge the monstrous toll of 1s. 6d. per 'horse-power,' as if it were a national object to prevent the possibility of such engines being used.

Sufficient evidence has been adduced to convince your Committee :—

1. That carriages can be propelled by steam on common roads at an average rate of ten miles per hour.
2. That at this rate they have conveyed upwards of fourteen passengers.
3. That their weight, including engine, fuel, water, and attendants, may be under three tons.
4. That they can ascend and descend hills of considerable inclination with facility and safety.
5. That they are perfectly safe for passengers.
6. That they are not (or need not be, if properly constructed) nuisances to the public.
7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses.
8. That, as they admit of greater breadth of tyre than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads than coaches drawn by horses.
9. That rates of toll have been imposed on steam carriages which would prohibit their being used on several lines of road, were such charges permitted to remain unaltered.

The Committee of 1831 made recommendations as to a Bill to regulate the tolls to be charged for mechanical vehicles and to prevent the imposition of exaggerated tolls. The recommendations, however, were not adopted, and the use of steam vehicles on the road consequently became practically impossible, although Hancock had considerably improved on Gurney's carriage, and up to 1836 was running highly successful vehicles on the road. After 1836 inventors from time to time came forward with improved road carriages, but owing to restrictive legislation they could not be put to any practical use.



GOLDSWORTHY GURNEY'S STEAM COACH. 1833. COKE FUEL

From an old Print

The consequences of this legislation were not long delayed. Automobile locomotion disappeared. Yet English builders of that period had already realised some excellent mechanical features. Certain among them had striking and remarkable schemes in regard to boilers, and had conceived extremely interesting 'water-tube boilers.' The boilers which my friends Normand and Thorneycroft to-day place on their torpedo-boats and torpedo-boat destroyers possess all the theoretical characteristics of certain apparatus conceived half a century ago.

Mr. Onésime Pecqueur, manager of the works connected with the Conservatoire for Arts and Inventions in France, designed in 1827 two very remarkable devices :

(a) The application of a differential gear to driving-wheels.

(b) The abolition of a forecarriage for steering-wheels replaced by the introduction of an axle fitted with two vertical pivots ; the wheels pivoting separately on each, and being kept parallel with one another by a connecting-rod.

It is impossible not to notice how very much this invention has controlled the fundamental principles in the construction of automobiles.

It is no exaggeration to say that without these two very important devices, the automobile would not, at the present time, occupy the very prominent and progressive position it does.

In 1873 the firm of Léon Bollée commenced the construction of their vehicles, which attracted so much attention at the Universal Exhibition of 1878 in Paris.

At this period one of the most remarkable carriages was a Victoria weighing approximately $3\frac{1}{2}$ tons, including its complement of 8 passengers, 390 litres of water, and 300 kilos of coal. The effectual horse-power varied from 8 to 20 h.p. ; the greatest speed obtainable was about 40 kilometres per hour. The design of the vehicle was well proportioned and carried out. The transmission to the driving-wheels was effected by

two chains and an intermediary shaft. The steering of the car was obtained by the revolving of the front wheels on two pivots set at an angle, giving a dish to the wheels.

The Bollée company constructed about this period many equally interesting cars possessing speed-changing devices. Since then the firm have built very many interesting cars of various designs, but a full description of these would take up too much time and space. Suffice it to say, however, these cars were as well constructed as designed, and that many firms have between then and now constructed cars far inferior to those of Léon Bollée.

In France, about 1885, the automobile vehicle was again in evidence, and attracted attention. At that time the Comte de Dion, at Paris, also constructed steam vehicles which ran in a satisfactory way. Then Serpollet devised his instantaneous vaporisation boilers, which reduce to a minimum the chances of danger, so far as steam engines are concerned.

After that time, automobile locomotion became a subject of talk, but the appearance in 1889 of a petroleum motor, with quaternary explosion features, gave matters an impulse which promises continuance.

In 1894, the 'Petit Journal' asked M. Pierre Giffard to organise the first meeting of automobile vehicles. It took place between Paris and Rouen, with a stop at Mantes. Although the design of the promoters was not that the vehicles should be run with a view to testing speed, the event from the very outset took on the character of a race. The Dion and Bouton steam carriage won the race, making the run at a mean velocity of about twelve miles an hour.

This was a sturdy little four-wheeler, on the back of which rested the pole-bolt of an ordinary carriage, the fore-part of which had been removed. This constituted a six-wheeled affair, remarkably supple and manageable, in spite of its length. The vehicle, empty, weighed 1·4 ton; loaded 2·25 tons, and could develop fifteen horse-power. The two front wheels, steering-wheels, were rubber-tyred; the rear wheels, driving-

wheels, iron-tyred. This motor had the interesting arrangements of the Dion carriage—that is, the use of a Cardan joint as a substitute for the Galle chain, and the movement of the wheel by means of a drilled nave.

Almost all the other vehicles were driven by Daimler petroleum motors. The vehicles of the firm Panhard and Levassor, which controls the Daimler patents in France, had at that time the same principal characteristics as they present



*Eckstein's Biographischer Verlag,
Berlin*

G. Daimler

to-day, which have been generally adopted. The motor maintained a fairly constant velocity of 750 revolutions; it acted on the drive-wheels situated at the back by means of a friction cone, a series of variable gears, a differential and a Galle chain; the steering-wheels were in front. The four-seated carriage weighed about a ton.

These carriages, as also the Peugeot petroleum vehicles, the motors of which were built by Panhard and Levassor,

worked with remarkable regularity, which, on the whole, demonstrated to those familiar with mechanics what a future there is in store for the petroleum carriage.

Though this first effort was attended with considerable success, the promoters of new methods of locomotion knew that much more remained to be accomplished. On November 18th, 1894, a most important meeting was held at the residence



Daimler Quadricycle, 1889, with Wilhelm Maybach and Paul Daimler

of M. de Dion, one which marked the beginning of an era of great development of automobiles in France. Those present at the meeting were Messrs. Baron de Zuylen, the Count de Dion, the Marquis de Chasseloup-Laubat, the Count de Chasseloup-Laubat, P. Gauthier, Ravenez, Peugeot, Levassor, Serpollet, Dufayel, Lavallette, Recoppé, Roger, Menier, de Place, Giffard, Emile Gauthier, Meillan, Nansouty, and Moreau.

It was decided at this meeting that, in the month of June of the following year, there should be a great race from Paris to Bordeaux and back (732 miles) ; that the carriages were to perform the whole distance in one trip ; and that repairs were to be made only by such means as could be carried. The contestants, according to the formula adopted, were to procure *en route* nothing but 'entertainment for man and machine.' This was, therefore, a race and nothing but a race.

In a test of this kind it was, as a matter of course, extremely difficult to establish a method of competing which should be at all logical and satisfactory. The elements entering into an appreciation of the merits and faults of automobile carriages are so complex, that up to the present time the most competent specialists consider it almost impossible to establish a general formula for the classification of contestants. It was hence resolved to adhere to the course, since a test of speed, so long and so hard, would of itself eliminate any vehicle presenting the slightest flaw or insufficiency of construction.

These provisions have been completely realised, and to-day a very long and a very hard course is the most assured means of testing a vehicle.

During several months the committee did considerable work ; for it was not only necessary to collect funds, but also to elaborate a set of regulations, and to obtain from the proper authorities the permission to make such trials of speed on the various sections of the route. In this arduous task the committee was most efficiently assisted by M. Marcel Desprez, Member of the Institute ; M. Georges Berger, Deputy of the Seine ; and especially by M. Michel Lévy, Engineer-in Chief of Bridges and Roads. Thanks to the efforts of the Committee, the whole matter was organised in spite of a multiplicity of difficulties. Numerous participants arrived ; among them it gives me pleasure to note two Americans—Mr. Gordon Bennett and Mr. Vanderbilt.

During the early part of June, when all was ready, the vehicles were for several days placed on view in a permanent

public exhibition, which attracted much notice. On the 11th of June, at nine o'clock, all the contestants were gathered in Paris, about the Arc de Triomphe. They started in procession, with no attempt at speed, toward Versailles, where the test was to begin. About eleven o'clock all the carriages lined up on the Place d'Armes at Versailles in front of the great château, according to their order of starting, as determined by lot. I verified rapidly all the marks which I had made during the exhibition by means of the stamp with which the Committee had entrusted me. I stamped also all the spare movables carried by the vehicles. Finally, at 12.5 noon, I gave the signals for starting, two minutes apart. This race, favoured by splendid weather, was a success and created much sensation.

Thanks to the co-operation of local authorities, of the Touring Club of France, of the Bicycle Association, and the instructions prepared by M. Varennes, there was not the least accident to any of the riders; all went well. The registration, both at fixed points and moving with the race, worked perfectly; and, on the other hand, the minute verifications of the marks of my stamp showed accurately that the contestants had really accomplished the task 'by their own means.'

M. Levassor returned to Paris, Porte Maillot, June 13, 1895, at 12.57.30, thus accomplishing the formidable course of 732 miles (Versailles-Bordeaux-Versailles-Paris) in 48 hours and 48 minutes. He supervised the machine himself constantly, except when ascending an occasional incline, when the rate of speed was comparatively slow, and then he had entrusted the lever to his mechanic. M. Levassor remained on his machine about fifty-three hours, and nearly forty-nine of these on the run. Yet he did not appear to be over-fatigued; he wrote his signature at the finish with a firm hand; we lunched together at Gillet's, at the Porte Maillot; he was quite calm; he took with great relish a cup of bouillon, a couple of poached eggs, and two glasses of champagne; but he said that racing at night was dangerous, adding that having won he had the

right to say such a race was not to be run another time at night.

The general mean of his velocity was 14·91 miles an hour ; the maximum was eighteen and a half miles an hour, between Orleans and Tours.

The vehicle which had accomplished this marvellous record without a single break-down or any stops (except those required to take in water and petroleum and one stop for cleaning, of about a quarter of an hour, near Bordeaux), weighed 11·87 cwt. without supplies or the weight of the two



'No. 5.' Winner of the Paris-Bordeaux Race, 1895, driven by M. Levassor
(Four h.-p. Panhard and Levassor)

men riding. It had three speeds, six, twelve and a half, and eighteen and a half miles an hour, the normal number of revolutions being 750. The motor, a new type of 'Phoenix' built by M. Levassor, was a Daimler, modified and much perfected. The Levassor carriage, like all the swift carriages engaged in this race, was mounted on solid rubber tyres.

A steam carriage, by Dion and Bouton, of about fifteen horse-power, which had been making between thirty and thirty-eight miles an hour on test, kept the lead to near Vouvray, on the banks of the Loire, where a break-down in the shafting

threw it out of the race. At that moment, in spite of losses of time, occasioned by the cleaning of gratings and the defective organisation of relays, where water and coke had to be taken on, this vehicle was a score of minutes ahead of M. Levassor's carriage. The first steam road-carriage of M. de Dion was probably, until quite recently, the most rapid in existence. After having undergone some modifications and improvements, it was purchased by M. Michelin, a large manufacturer of pneumatics, and it continued for some time one of the swiftest and most stable in the maintenance of velocity. It weighs a little less than two tons, and with its twelve to fifteen horse-power easily and without strain makes thirty to thirty-eight miles an hour on the level.

Other carriages of Panhard and Levassor and of Peugeot likewise made good records.

The characteristic feature of the race of 1895 is the triumph of petroleum over steam. I gave the signal for departure at Versailles to fifteen petroleum and to six steam vehicles; we noted the return to Paris of eight petroleum vehicles and of one solitary steam carriage. This latter was the heavy omnibus by Bollée, constructed and run by those able engineers of Mans, who covered the course in spite of numerous break-downs, thanks to extraordinary physical endurance, and to a mechanical skill worthy of their excellent reputation.

The only electric vehicle entered in this race was constructed by M. Jeantaud, the eminent builder, who has since then made a speciality of electric carriages. It was a remarkable piece of machinery, especially for that epoch. But owing to the warping of the axle of one of the front wheels, due to a shock, he could not cover the route swiftly enough to utilise the relays of storage batteries which he held in readiness along the line.

After having distributed the prizes, and made its report as a whole, the committee of the Paris-Bordeaux race, on my proposition, declared itself a permanent organisation, designed to give to the automobile industry a rallying centre and

encouragement based on conditions of competency and impartiality.

Some months later, MM. de Dion and de Zuylen took the initiative in changing the permanent commission into a sub-committee, adjunct of a society for the encouragement of automobile locomotion ; thus the Automobile Club was born, which, in three years and a half, had grown, as to the number of its members, from about fifty to nearly two thousand ; and now (January 1902) has over two thousand members. This Club, by reason of its large pecuniary resources, and also of the liberal and scientific spirit which animates the encouragement it gives in every way to the new industry, is certainly to-day one of the most useful and commendable institutions in France.

The Automobile Club of France, for which we have selected the abbreviation 'A. C. F.,' resolved to organise a race from Paris to Marseilles and back for September 24, 1896. This course, 1,061 miles in length, could certainly have been covered in a single trip by machines with relays of men ; but the incontestable danger which a night run at full speed involves, led the committee to adopt the principle, which has since been followed, of a test by stages, so regulated that vehicles shall not be obliged to run by night save in cases of long delays due to breakdowns on the road.

It was decided that the start should be made at Versailles, and that the course should be divided into ten stages : Auxerre, Dijon, Lyons, Avignon, Marseilles, Avignon, Lyons, Dijon, Sens, Paris. In each of these towns the vehicles were to be put up in a park under surveillance ; the replacing of broken parts was prohibited, but ordinary repairs could be made by whatever means came to hand. Of the thirty-two vehicles ranged about the Arc de Triomphe de l'Etoile on September 24 at nine o'clock in the morning, which began their run to Versailles on the same day towards noon, twenty-nine returned to Paris. The three which broke down were the only steam vehicles. Another triumph for the petroleum carriage.

This race was again won by a Panhard and Levassor

carriage, which covered the entire course in 67 hours 42 minutes and 58 seconds, equivalent to a mean velocity of 15·65 miles an hour. This carriage was followed closely by other vehicles of the same house. The greatest speed during a single stage was about eighteen miles an hour.

The Peugeot carriages also did good work. The firm Delahaye of Tours made its reputation on this occasion by one of its vehicles, which came in a good fourth.

But the most prominent event of this test was the extra-



'No. 6.' Winner of the Paris-Marseilles and back race, 1896,
driven by M. Mayard

This was the first four-cylinder carriage built. (Eight h.-p. Panhard and Levassor.)
Afterwards purchased by the Hon. C. S. Rolls.

ordinary power of resistance displayed by the new petroleum tricycles constructed by the firm Dion and Bouton. Contrary to all prognostications, these diminutive vehicles, the weight of which is hardly more than that of the man who mounts them, covered the immense course almost as fast as the carriages, in spite of horrible weather and a veritable equinoctial cyclone during the second and third days—from Thursday, the 24th, at midnight, to Friday, the 25th, at noon, the barometer fell about $1\frac{1}{8}$ inch.

As to the three steam vehicles, they could not accomplish the course. The Dion carriage, which had run the Paris-Bordeaux course, and which was driven by M. Bouton, stopped at Suresnes, even before the start was made, in consequence of a rupture in its large new pneumatic tyres, which M. Michelin had fitted to it without having studied and perfected them sufficiently.

The two other steam vehicles were almost identical brakes, especially constructed for this race, weighing about three tons when made ready for the trip, developing about eighteen horse-power when run in compound, and probably a little more than thirty when run by direct action from the large cylinder. Of these two powerful machines, one, in charge of M. de Dion himself, could not go further than Montereau, about eighty kilometres from Paris.¹ The other, of which my brother and I had taken charge, with a fireman and two machinists, took eighty-five hours to reach Lyons. During this long trip (we had only twelve hours' rest, from Friday midnight till Saturday noon), we spent forty-seven hours on repairs, on the open road—part of the time, and that the greater part of it (the night of Thursday to Friday, and of Saturday to Sunday), in a drenching rain. It goes without saying that, at the end of a dozen hours so lost, we made not the least pretence of catching up with our more fortunate competitors, but we wished to make a fight for the honour of the steam-principle by at least finishing the run, a purpose which we did not relinquish until the machine was entirely crippled at Lyons.

Almost every part of the mechanism was out of working order, and we had every break-down conceivable, except an absolute explosion of the boiler. We had even carried away a piece of the frame, which we replaced by means of an iron bar, forged by ourselves in a village.

I shall not attempt to give here complete details of this eventful journey, of which, however, I made most careful notes at the time. Exhaustive enumeration of all that happened to us

¹ An illustration of this car is included in the chapter on Steam Cars.

would prove too lengthy. Suffice it to say, that we ran down a dog, overturned two carts (whose drivers, frightened at the sight of our enormous machine, turned to the left at the very last moment), upset a cow, and finally broke down a fence in trying to make a turn on soft and heavy soil. As for ourselves, in spite of our rubber hats, vests, and trousers, and the provisions of all kinds which we carried with us, we were in a condition which I prefer not to describe. My brother and I have been over some pretty rough ground in travelling—notably in India, in Japan, in Central Asia, and in the Sahara—but never were we so utterly tired out and so devoid of every similitude of humanity as when we reached Lyons.

In spite of all that, this carriage is a good vehicle. The accidents that happened to us were due to the fact that the machine had started without sufficient preparation and test. The proof of this is that, a few months later, in January 1897, the same carriage, in charge of my brother, after some modification and improvement, won in a brilliant manner the Marseilles-Nice-Turbie race, covering the 145 miles in 7 hours 45 minutes 9 seconds, a mean velocity of about eighteen miles an hour. This result is still more satisfactory if the exceptionally uneven and sinuous nature of the road is considered, as also the stops necessary to take in water and coke, and in fact that, without facing certain death, one dared not let the heavy vehicle coast on any of the heaviest down-grades.

It was on one of those down-grades that Charron, who was running a Panhard petroleum carriage, and who wanted to catch up with us at any cost, was upset at a turn. Charron and his machinist were thrown out, though they were not hurt at all, but the vehicle turned a complete somersault, and landed on its wheels—as was demonstrated in an undoubted way by the traces of gravel on the upper part of the carriage. It sustained no serious injury, except the destruction of the steering bar, which Charron repaired with a bit of wood. It returned to Fréjus without a stoppage of the motor.

The tests of Paris-Bordeaux and Paris-Marseilles had shown that automobile carriages can cover long distances on ordinary roads; Marseilles-Nice-Turbie went to show their practical value, by proving that they could get over the heaviest down-grades.

It was also on this last occasion that really considerable velocities were attained for the first time. Between Ollioules and Toulon we made five kilometres (3·1 miles) in less than five minutes; between Cannes and Nice, the speed officially registered for Michelin was about thirty-one miles an hour; ours was a little greater than that, since Michelin had left Cannes on his steam brake five minutes after us, and we were stopped for eight minutes on the outskirts of Nice by an overheated axle, during which time he ran by us like an express train. The second prize was won by a Peugeot petroleum carriage; for, in the first part of the run, Michelin had lost considerable time by the rupturing of his pneumatic tyres, which he had not yet been able to bring to the highest degree of perfection.

In 1899, I wrote :—‘This race was the only one ever won by a steam carriage, and it will probably be the last, in view of the incessant progress made to-day in the construction of petroleum motors, making it possible for them, other things being equal, to develop power superior to that of steam apparatus, as far as now known.

‘Of course the petroleum motor has not the elasticity of a steam motor, but it has a peculiar steadiness and a wonderful power of endurance. It has but one weak point, its cylinder, and but one delicate structure, its carburetter; while the steam engine has numberless sources of injury in its boiler, its tubings, its pumps, its cylinder-heads, &c., which are simultaneously subjected to extreme pressures, due both to the steam and to violent jolts on rough roads. Besides, to make a one-horse-power hour with a petroleum motor requires about 0·750 kilo of oil, and since the invention of the radiator or surface-condenser, the same water can be used indefinitely

for cooling the cylinder. On the other hand, the steam motor requires for the horse-power hour about one kilo of fuel and ten kilos of water. The stops necessary to replenish are, therefore, much more frequent with the second of these systems than with the first.'

Since these events speed in races has constantly increased. In the Paris-Dieppe race in July 1897, a small Bollée carriage, a sort of tricycle with rear driving-wheels, made the run at a mean speed of about twenty-six miles an hour. Almost the same record was made by the first contestants taking part in the Paris-Trouville race, 105 miles, in August 1897. In the great race, Paris-Amsterdam-Paris, in July 1898, made in several stages, Charron, running a Panhard two-seated carriage, attained a mean velocity of 27.77 miles. Finally, in the Versailles-Bordeaux race of 1899, one stage without stop, the mean velocity attained by the winner, Charron, on the total run of 351 miles, was 33.30 miles. On certain quite lengthy stretches of the course, the mean speed passed thirty-eight, and at some points reached forty-five to fifty miles an hour. This carriage, from the establishment of Panhard and Levassor, weighs about a ton, and carries an equipoise motor of from twelve to fifteen horse-power.

Having traced the history as far as this interesting event, I must refer the reader for further information to the chapters dealing with the work of the automobile clubs and the records of races and trials.

It would not be out of place for me to make a few remarks concerning those all-important factors which go to make the sport of automobilism a success.

Tyres.—It is impossible to refer to pneumatic tyres without recalling the firm of Michelin et Cie. With iron-tyred wheels it is impracticable to drive quickly without destroying, in a very short space of time, first the wheels and then the carriage.

With solid rubber tyres slightly more speed is obtainable, but the pneumatic is the only one with which, at present, it is possible

to attain high speeds with a measure of safety, and without causing the wheels to collapse, and damaging the transmission gear of the car, not to mention springs, frames and motor.

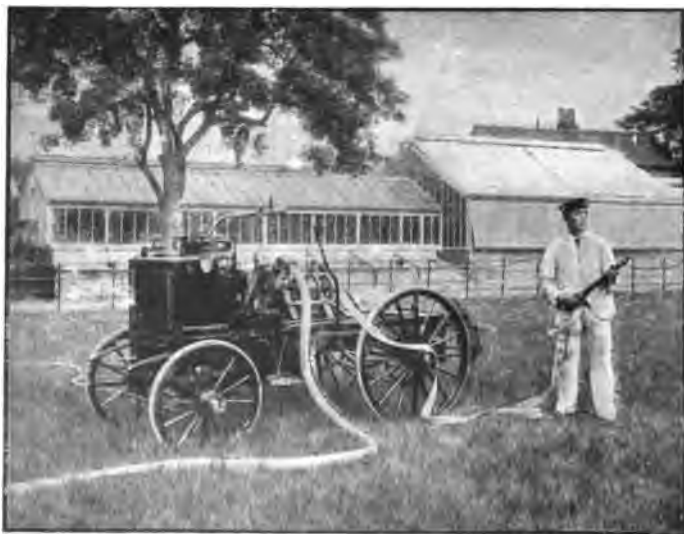
The part played by the pneumatic tyre at high speed is enormous : to quote Mr. Michelin's remark, 'it absorbs every obstacle' ; it acts as a cushion and a spring, and reduces to minimum the very formidable objection of vibration.



The first Petrol Car introduced into England—the Hon. Evelyn Ellis's
4 h.-p. Panhard and Levassor Car

The revival of interest in mechanical road locomotion in the United Kingdom which followed the extraordinary performance of the carriages of 1895 in France was at first very gradual. The Hon. Evelyn Ellis introduced a four-horse-power car into England in the June of 1895, having used it in France for some time. Mr. J. A. Koosen on November 21, 1895, imported a Lutzmann car. Sir David Salomons

gave a demonstration of motor vehicles at Tunbridge Wells on October 15, 1895, at which members of Parliament and other prominent people to the number of fully ten thousand were present. In the meantime, a financier had purchased from Mr. F. R. Simms the rights for the United Kingdom in the Daimler patents. An exhibition of motor vehicles was held at the Imperial Institute, London, in 1896. At the same time companies having prodigious capitals were

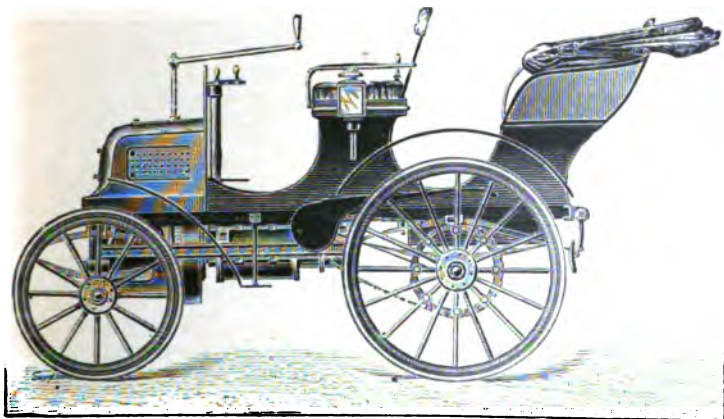


The Hon. Evelyn Ellis's original 4 h.-p. Panhard Car converted into a Fire-engine.

floated, and when, on November 14, 1896, motor vehicles were allowed to run on the roads, popular enthusiasm had been thoroughly aroused, and the start of what was virtually a race from London to Brighton on that day was witnessed by an enormous crowd.

It is only right that it should be recorded here that Mr. Ellis took up the motor movement from patriotic motives, and

supported some of the pioneer companies from his private purse to the tune of probably 20,000*l.* Sir David Salomons, although not financially interested in the industry, worked with great zeal and energy with a view to making the running of motor vehicles on the road permissible, and spent very many hours in advising the Government officials as to what the law should be. Mr. Shaw Lefevre, as President of the Local Government Board, was about to introduce a Bill when in 1895 the Government went out, with the result that the honour of bringing before Parliament the Light Locomotives Act fell to



The first car built by the Daimler Company at Coventry

his successor, Mr. Henry Chaplin. Mr. Henry Sturmev, who had long been associated with the cycle press, was quick to recognise that the motor-car movement was to attain prodigious proportions, and on November 2, 1895, he produced the first number of a newspaper called 'The Autocar.' This he wrote and edited personally himself, unaided, for over a year, and continued the editorship of the paper until 1901. The 'Automotor and Horseless Vehicle Journal,' 'The Motor-Car Journal,' and other journals followed, but the honour of

being first in the field belongs to Mr. Sturmev, who also did much to illustrate in this country the practical utility of the automobile by making a journey from Land's End to John o' Groat's in October 1897.

Mr. T. R. B. Elliot (who, on December 27, 1898, was the first to drive a motor vehicle, a three-and-a-half horse-power Panhard, in Scotland, and drove 1,250 miles before the Act was passed), and the Hon. C. S. Rolls, who acquired a three-and-a-half horse-power Peugeot in December 1896, are amongst others who followed the lead given by Mr. Ellis and Sir David Salomons, by driving motor vehicles on the English roads before the law of 1896 came into operation.

The later history of automobilism in the United Kingdom and other countries will be found in the chapters on the work of the various Automobile Clubs and on Records.

CHAPTER II

THE UTILITY OF MOTOR VEHICLES

BY THE HON. JOHN SCOTT-MONTAGU, M.P.

IT is now admitted by most people that the motor-car has passed the limits of mere experiment, and that it has become a practical vehicle. Motoring has already entered, and will in the future enter yet more largely, into our social life, though we may still be far from the time when the horse-drawn vehicle will be a rarity upon country roads and London has begun to save fifty thousand pounds a year now spent in road scavenging.

The utility of the motor is endless. At whatever distance you may live from your station in the country, the motor is bound to shorten the time occupied on the journey to and fro, and houses six miles from a railway become as accessible as houses three miles distant are to-day with horses. Whether you consider the motor from the town or country station point of view, the fact that there are no horses to get tired, and that the motor will run, providing it is efficiently handled, for any hour or all hours during the twenty-four, makes it inevitable that every country house of any dimensions, and nearly every private carriage-owner in London, will have a motor-car of some sort or kind in coming years. The difficulty at first is always the same in any new movement of this kind: the would-be buyer and future owner most probably knows nothing about the machine of which he is to be the possessor, and to get a trustworthy and capable driver and mechanic is even harder than the selection of the motor in the first instance.

I am inclined to think that for town work electricity and steam will be the main propulsive agents. The delightful

smoothness of either method, and the fact that, in the case of electricity, re-charging can be done so easily from any electric light system, are advantages not to be denied ; and again, as broughams and landaus are largely used for night work, the same power that produces the motion will produce also a most brilliant light for your lamps, light your cigarette, and heat your foot-warmer. If it were not that there is yet no really satisfactory form of accumulator for traction work on the market, the electric motor-car would long ago have won a complete victory. At present an electric car may be classed as a charming but expensive vehicle, almost as costly as horseflesh. The expense of running an electric carriage, including stabling, electricity, tyres, batteries and insurance, is 180*l.* per annum. The steam car has been more favoured of late, but here again you have the danger which must necessarily come from a live flame in connection with petroleum or petroleum spirit—always called amongst motorists ‘petrol’—and most of the steam vehicles now upon the market are extremely expensive to run, in fact nearly three times as expensive as an internal combustion engine producing the same power. I feel convinced that we must have a great improvement in steam vehicles before they will come into general use for light town work, and electricity ought certainly to hold the field, so far as one can see, for some years in this department.

Of course I am not discussing the question of heavier traction, the vehicles for which have been much more perfected than those for the lighter class of work. The Liverpool trials last summer, and the military trials at Aldershot in December, proved that we can buy vehicles of undoubtedly great carrying power, and of ‘extra-normal’ capacity, able to tackle not only heavy roads and stiff hills, but even to make a fair show across country. There is probably nothing safer in the streets of London to-day than a well-driven electric or steam motor ; there are no horses to fall down when the streets are slippery, and there is brake power available far in excess of any that can possibly be exercised by the horse with his four iron-shod feet

on a frequently treacherous surface. When your driver is careful and competent, has learnt the danger of skidding, and is content to take you round corners at a reasonable speed when the wood pavement or the asphalt is wet, you should be able to enjoy your newspaper or talk to your companion as you go



A Station Omnibus
(Eight h.-p. Panhard and Levassor)

along with as much serenity as if you were sitting in your favourite chair at home.

To turn for a moment to station work in the country. There is no doubt that the internal-combustion engine driven by 'petrol' is still the most practical of all the various types. Whether you have a Panhard or a Mors made in France, or a Daimler or a Napier made in England, on ninety-nine days out

of a hundred the vehicle will perform its work up to time, and, so far as I can speak from my own experience, you ought never to miss your train or your appointment if the car is efficiently superintended. One thinks a good deal in the country of going by train to one's station, say a hundred miles from London, in about two hours, and you naturally remark on the excellence of the railway service, but from there to your house, a distance of, perhaps, six miles, often takes you an hour in the country fly. The first part of your journey was completed at the rate of fifty miles an hour, the final average from door to door works out at a little over thirty. If the train service from your station is quickened to any centre which you are using by ten minutes in two hours, you think it is an extraordinary improvement and everybody praises the railway company; but with a motor you may save thirty minutes in every hour over the horse-drawn vehicle even in ordinary weather, and when it comes to snow and frost and slippery roads the saving might easily amount to far more.

And when you are in your country house what an added joy to your daily life! Perhaps you are surrounded by a few near neighbours of whom you have seen almost too much, and beyond them a wider circle of friends from ten to twenty miles off, or even more, whom, without previous arrangement as to change of horses, you cannot conveniently reach. These now become quite accessible, and a shoot twenty miles from home can be undertaken, or you can lunch with your neighbour five-and-twenty miles off as easily in 1902 as in 1892 you could meet your friend living seven miles from your door. All this makes for an improvement of the social conditions of country life, a widening of its opportunities, a better knowledge of your county, and less boredom with your parish. But beware of the local Bench in the matter of speed. They may be sensible, and the policeman kind or blind, but all are not so. The poetry of pace generally leads to a payment before the prejudiced. Above all be a gentleman on the road as well as off it. It pays.

Then, again, as to the station work : your expected friend, we will imagine, misses the train ; but there is no horse to catch cold waiting at the railway, followed by an intimation from your groom next morning that the horse cannot be used for three or four days owing to a bad chill. Altogether the motor-car must revolutionise our social life in the country, and let us hope before long will lead to the bettering of our cross-country roads. The horse, poor beast, has never been able to tell us what he endures from bad roads, and the pace of a horse-drawn vehicle has been too slow for even the springs to suffer much ; but if you get into a motor-car going five-and-twenty miles an hour over a road which you have hitherto deemed good, the engine and car will very soon tell you the difference between what the road surveyor's work has been and what it ought to be.

For station work in the country I would rather recommend—and I am supposing myself writing for those who have now a stable of some half a dozen horses—a covered as well as an open motor, or perhaps a motor which can have a top fitted on to it when the weather is bad. Ladies do not like arriving at tea-time with their fringes out of curl, or the feathers in their hats drooping or facing the wrong way ; but always remember that the driver should be quite free, and that nothing is more dangerous on a misty day, and especially at night, than a glass frame on which the rain will fall and eventually almost obscure the road from his gaze. The man who drives the motor must always have the best possible view of the road, just as on the footplate of a locomotive every driver knows that in times of mist or rain the difficulty of seeing through the windows of the cab is immensely increased, and careful drivers prefer to have their heads round the edge.

For hunting work you must bear in mind the susceptibilities of the district. I am glad here to be able to put on record—for it will seem curious a few years hence—that a Master of one of the Midland packs has asked the members of his hunt to avoid using motor-cars for the purpose of coming to meets,

and generally to discourage their use, on the ground that the farmer will be deprived of part of his income owing to the diminution of the demand for forage, by which hunting will be prejudiced. It is notable that similar arguments were used in the years 1838 to 1845 during the construction of the early railways; and yet the horse is with us still. It would be rash to say that the farmer will lose by the introduction of these new vehicles, but if he loses in the amount of corn or hay sold for a few covert hacks or carriage horses, he may gain by the fact that many more people will hunt if they have facilities for



A Covered Carriage built by J. Rothschild & Fils

attending distant meets, and that the farm produce itself will probably be conveyed at a much cheaper rate than is possible now either by horse-haulage or rail. There are notable Masters in the Shires who already employ motor-cars to take them to their more distant meets, and as I write I have the names of several gentlemen in my head who would be recognised throughout the hunting world to be as good sportsmen and as straight riders as any in England. The use of a motor for every kind of social appointment is bound to increase, and I am afraid some of the Midland farmers are

more like Mrs. Partington than they could be persuaded to believe.

To come to other country pursuits, both for shooting and fishing, rapidity of transport will do wonders. You have often, for instance, in Scotland a lodge near your forest where the stalking is good, and possibly a few brown trout in the burn below. But ten miles away, perhaps over a good road, there is an excellent sea trout or salmon river which is only accessible after a good deal of organisation, and if the road is hilly, the expenditure of an hour or an hour and a half of time. The new mode of locomotion will make river, loch, and forest accessible from the same centre. Moreover, many places in Scotland which are beyond ordinary driving distance from the station, thirty or forty miles away, will not be so cut off from the outer world as at present, and your 'Times' will be only one day instead of three days late. On precipitous roads, if your horse backs you have frequently a very nasty moment or two; but motor-cars do not shy, neither do they back unless you wish them to do so. Proverbially, once more, there is nothing so uncertain as fishing. You may have a good day and wish to stay till the very latest moment, or the water may be out of order, the fish not on the rise, and you may find it desirable to alter your whole day's plans. If you have driven a long distance the horses must have rest, and very often have been put up at a farm some way from the water, whereas the motor is left on the road at the spot nearest the stream, and should you decide in favour of some other kind of sport, or a return home, you can change the rod for the gun, or rejoin your wife, go back to your garden, or possibly to 'bridge' or 'ping-pong.'

For ordinary partridge- and pheasant-shooting in England motors have already taken their place as practical vehicles; and I may here remark that it is all-important that we should not lead motor manufacturers to imagine their cars are only to be used in the summer-time, when the roads are good and when you can arrive at the end of your journey with your paint showing in all its glory. For country work the car ought to be

able to run all the year round, and whether it is smothered in mud, or almost obliterated by snow, to be of practical use you should not spare the car in the winter-time. You will find out more weak points and need for alterations in one day in December than in a dozen days in June. Have, say, a six- or a twelve-horse-power car for the loaders, a good roomy wagonette with a low gear and plenty of floor space, let them start a quarter of an hour earlier than you, and follow them in your flyer, on a twelve- or twenty-horse-power machine with your guests. Many a last beat of a good shoot has been spoilt because one of the party was not called in time, or was eating his breakfast when the party ought to have been starting. You can now allow a wider margin. The beats which, if you left home at ten, were finished with difficulty, can by the aid of a car be so accelerated that at the end of the day you will probably have a quarter of an hour in hand.

And there are other forms of shooting which can now be enjoyed and which formerly were impossible. I will suppose that your shoot has many natural advantages, and that there are duck pits and snipe marshes at certain places on the property. With two good motor-cars such as I have described you can take four or five guns and loaders; you can visit all of these places in the day, and make a total of wildfowl and snipe which the Game Book will tell constitutes a record. I have myself worked on this system for three or four years past with great success, and a hundred wildfowl a day shot out of small lakes and pools, added to a few snipe and 'oddments,' will make your day one to which you need not disdain to ask your best shots and your cheeriest friends. Twenty to five-and-twenty miles like this can easily be covered by your motor, and you will hardly realise the distance you have been over by the time you return home. To ask any pair of horses, or even a four-in-hand brake, to cover the same mileage, with the roads bad as they generally are in the winter, muddy and soft, with, probably, five guns in the one brake and five loaders in the other, and perhaps



'GUNS' ARRIVING BY MOTOR

an extra keeper and a dog or two thrown in, is such a serious business that you will find four pairs of horses can barely do the work, and next day they will very likely be unworkable.

Let me give one word of advice as to motoring to your shoot. Always wear spectacles, and have a pair or two for your guests who sit on the front seat with you. The keen air of a frosty morning, or driving rain at top speed, will not increase the accuracy of your aim, let alone the chance in the early autumn of a gnat in your eye, than which nothing can sometimes be more painful, or, later on in the year, a speck of gravel which may cut you like a knife.

As to wildfowling, you can go to your punt more rapidly in the morning, and an extra ten minutes in bed will be welcomed by anyone who has had experience of early punting. You can also, when the opportunity presents itself, shoot your Golden Plover from the motor-car without any chance of your horse suddenly bolting at the discharge, and wood-pigeons and cock partridges later in the season can be brought down from the road after a little practice with the greatest ease, without rising from your seat. Rabbits and hares at night will run sometimes for a quarter of a mile before your acetylene lamps, and you can pick them off in the same way with your gun; oftentimes with your car you will unintentionally run over panicked rabbits or hares who dash frantically under your wheel. It is always worth while stopping to see whether you have secured your quarry; and although the mode of killing may result in the hare being more fit for soup than for roast, at times you will be lucky, as I have been, and a head that its mother would not know is the only damage done.

For household purposes, if you live at a distance from your country town, you will find a motor car of great use for parcels, for sending away your game, and for bringing your supplies; and let me also mention that your servants, should you care to give them a day's outing in the summer, will enjoy a motor-car drive and a picnic in the woods with a zest which they never knew in the days of the horse-drawn vehicle.

Now I come to the last section of my chapter, the use of motors for farming and estate work. And here one must go from the point of view of convenience to that of economic and practical use. Whether the rates charged by railways to-day are justifiable, having regard to the capital of those railways, or whether they are excessive with regard to the low rates charged on competitive foreign produce, the cheaper and swifter locomotion becomes, the better must it be for the British farmer; and incidentally I must strongly advocate some form of co-operation where it is possible. At Tunbridge Wells a system has been started, whereby the farmers of the district, tired—and no wonder—of the vagaries of the South-Eastern and Chatham, have organised a motor service to take their goods direct to Covent Garden and other markets in London. And just think for one moment of the advantages gained. There is no handling from the farmer's cart into the truck, with all its attendant risks to perishable articles; and there is no handling at the London terminus, with the risk of crushing in the carrier's or railway company's van. The motor-car takes the fruit, or whatever produce is desired, to the market, and thus there are two handlings as against four handlings. Not only this, but the vehicle can return from London, or the town you may chance to be near, with nitrate of potash, bone meal, linseed cake, or whatever you are buying from the outside for consumption or distribution on your farm; and as every merchant in the world will tell you, the secret of paying freight is that the vehicle or ship should be full both ways. What an advantage it would be to London, and what a saving would result, if you could have fresh eggs gathered from five to seven in the morning and delivered to you at your door at eight or nine o'clock for breakfast! Nowadays only milk and cat's-meat are taken to your house, both moderately fresh, but the London egg is neither moderate in price nor is it generally new-laid. The cry of 'cat's m-e-e-a-at!' may bring but few householders of the better class to the door, but we may live to hear a long-drawn-out cry of 'e-g-g-s!' which will tempt every housekeeper

with her pennies in her hand to get the early morning egg fresh for breakfast. There is also the fresh fruit and vegetables which in future days, perhaps, a fatherly or grandmotherly municipality will distribute in their cars to you.

The use of motors for market and farm work is yet in its infancy, but I can see no reason why the distribution of perishable goods from a moving centre should not be one of the improvements of coming years. Take, again, the instance of thousands of acres of land in this country which are from six to ten miles from a railway station, with perhaps a rail journey of another ten to the county or market town. By a little arrangement and organisation tenants farming this land could, three days a week, send their produce to market, and, moreover, if it is not sold at satisfactory prices, the articles could come back at no greater expense than that which it would cost to run the car, which in any case would have to return, and is not likely always to have a full load. The grip of the provincial salesman on the farmer lies in the fact that if the latter takes his produce to market he must sell it before the end of the day, for to bring it back by rail, and to have a cart to meet it at the other end, would be financially suicidal. The farmer, therefore, is always at a disadvantage, and the middleman takes a bigger proportion out of the agriculturist than perhaps in any other trade.

For estate work, where there is a staff of builders or carpenters, a motor-car will prove a great saving. When once the capital outlay is faced, scattered cottages and farmhouses can be more easily and economically examined and attended to, and perhaps repaired even in the hours between sunrise and sunset. If your carpenter or bricklayer has to walk five miles to his work, in the winter, he will certainly not begin much before nine o'clock, and he will walk back in your time and not in his. Small blame to the man for that. The absolutely efficient hours of labour are thus reduced by nearly thirty-three per cent., and the work will cost you correspondingly more. In the case of the breaking down of a bridge,

or the falling in of a roof, or the choking of a drain, you can concentrate, by means of a motor that will carry ten to twelve persons in it, a large force and meet the emergency, and perhaps save the situation before any very great damage is done. I should recommend for estate work a good rough wagonette which can take materials as well as persons, with plenty of engine power, say, not less than twelve-horse, and a low gear which will make a load of bricks or half a dozen bags of cement a possible freight. And, above all, have electric ignition, and only use tube ignition, if you have it, in cases of emergency or breakdown in your electrical arrangements. Otherwise a flare-up and a charred car is a daily possibility.

It is necessary that an agent on a large estate should be as independent of time and distance as possible. Give him a light motor-car, and let him get one of his stable-boys or farm-hands properly instructed in its care and use at one of the centres of the automobile industry. His work will be more efficient and his control of his staff more complete.

Although I may be accused of prejudice, I personally favour an English-built car for these purposes. The work in them is, I believe, better, the material is certainly stronger, and as strength and durability are more essential for practical work than paint and artistic lines, I should recommend my readers to go to the well-known English firms for their vehicles.

For golfing, yachting, and in fact for every pursuit where you have to go from home to begin your day's amusement, the saving of time will grow upon you, and give you more leisure moments and more hours of amusement. The War Office, who have of late become more practical in these matters, are genuinely taking efficient steps to perfect mechanical traction for the army. The one department—the Post Office—which has especially to cover long distances, and to whom the saving of time ought to be, but apparently is not, of the utmost importance, appears stolidly indifferent. Just as for years after the introduction of railways the Post Office fought shy of the use of

them for mails, there are still provincial towns near London to which a seedy pair of horses and a broken-down-looking driver convey His Majesty's mail every day or night. We have no chance at present of seeing a saving of time in the matter of the rural postmen or the provincial mail-cart. Why should there not, for instance, be a late motor-mail service from London, leaving about two A.M. after all the main-line railway services have ceased, to convey letters, perhaps posted with a late-fee stamp, up to midnight for the country, and deliverable in towns within a hundred miles of London by the first post next morning? I am confident that were an experiment of this kind started the number of letters so posted would very soon make the demand for motor-cars a very large one on behalf of the Post Office, and the convenience to the public would be undoubted. From eight o'clock in the evening until eight o'clock the next morning you cannot telegraph to most country towns, and after eight o'clock, unless you send to the mail train at the terminus, correspondence by letter is impossible. There must be thousands of people every night in London, and in every provincial centre, who would gladly pay an extra penny, or even twopence, if they knew that by so doing a letter would be delivered next morning by the ordinary first post. A motor-car also enables one to send a written message to a telephone station night or day.

That the motor-car has come to stay is a commonplace, but few can foresee what a change it will make in our economic, political, and social life. I believe that the revolution worked by railways is a small thing compared with the revolution to be produced by the motor-car.

CHAPTER III

THE CHOICE OF A MOTOR

BY ALFRED C. HARMSWORTH

Few undertakings require more care and caution than the choice of a motor-car. Of the three or four hundred types and varieties now in existence, many are of no practical use, some are extremely complicated, not a few dangerous, and many more or less faulty in construction. The difficulty of the choice is increased by the fact that almost every enthusiast recommends the particular kind of carriage he himself possesses, and in addition every manufacturer claims, and possibly believes, that his is the only possible automobile.

My own experience, though not nearly so extensive as that of such veterans as Mr. Rolls and many others, is, I venture to believe, as varied as that of most chauffeurs, and I think I can claim to be free from prejudice. I am running at present four cars of French construction, two of American, two of English, and some others which are practically English. Three are driven by petrol, three by steam, and two by electricity.

I shall speak quite frankly of each method of propulsion. To-day my own experience teaches me that in the year 1902 a good petrol engine is infinitely the best for all-round work. That is to say, if one intends to own a single motor-car only, and desires occasionally to travel for long journeys, there can in my judgment be no doubt that a petrol engine, with a Daimler or some similar type of motor, is the wisest purchase. The point is a contentious one; but I selected this type of engine as the best for use five years ago, and since then time

has brought almost every motor manufacturer to my side. One after another the Continental makers have copied the shape and design of the Panhard carriages, which are in most respects similar to those of the English and German Daimlers. Among the many advantages of this type of engine is that it is easy to get at, is simple in construction, understood by more mechanics than any other engine except perhaps the De Dion in France, and so lasting in quality that Mr. Evelyn Ellis, who brought the first four-horse motor to this country in 1894, still has it, though it now does duty as a fire-engine.¹ My own six-horse Panhard, which was one of the earliest of that type, is as good



The English Daimler Company's 22 h.-p. Car ²

to-day as it was in 1896, and my six-horse Daimler, though only two years old, has done an enormous amount of rough work, and is in every respect as good as on the day it was made. My steam-engines have given me some trouble, though improvements are being devised with great rapidity; but in the smaller types the necessity of taking water, nominally every fifty miles but in reality much oftener than that, their fragility of construction and difficulty of management in a high wind, render them at present only useful to those who thoroughly enjoy a mechanical task.

¹ See the illustration in Chapter I.

² The illustrations in this chapter are given simply to represent some of the types of cars now in use.

Quite the most perfect cars are my two electric carriages, one a Columbia phaeton, and the other a small brougham supplied by the City and Suburban Electric Carriage Company ; but—and it is a big but—they are limited to a range of fifty miles, and though there are constant improvements in batteries, and electric charging stations are springing up all over the country, I can only at present recommend them for a twenty-mile radius round a house in town or country— for that work they are not to be excelled. Only those who have suffered the experience of seeing a valuable pair of horses losing their step and style



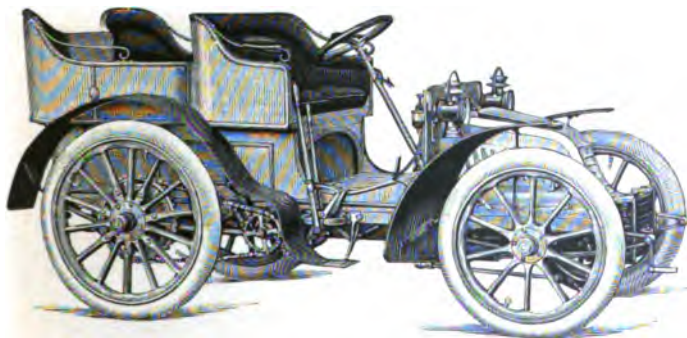
A Benz

can realise what a help to a stable it is to have one electric carriage on the premises. For shopping, theatre and station work, an electric carriage is an inestimable boon.

In considering the purchase of a motor-car I will assume that the reader desires only one, and that it will be required to do all kinds of work. This involves, then, that such a carriage must be either closed or else so made that a top can be fixed to it. Altogether insufficient attention has been paid to the ques-

tion of covered carriages in England, but not so in France. One of the most noticeable features of the Exhibition of December 1901 was a recognition of the fact that a motor is not a mere fine-weather phaeton, but a carriage to be used at all seasons.

Assuming, again, that the reader has decided on a petrol car, the matter becomes a question of cost. We have been told for a number of years that the motor-car would soon be very much cheaper, but so far this is only partially true. The day of fancy prices caused by the demand of very rich people for something of which the output is very limited is almost gone, but it is difficult to suppose that one will ever be able to buy a well-built carriage, drawn by a complicated and beautifully



Eight h.-p. Peugeot (1902).

constructed piece of machinery, for anything approaching the price of a mere brougham or victoria. Yet that is what many people are expecting, forgetful of the fact that a motor-car is a horse and carriage in one, that its stable bill is of the smallest, that it ceases to consume oil or spirit immediately it is at rest, and that although its tyre bill, and accounts for occasional repairs, may be high, it is not subject to half the troubles that worry the owner of even the best-conducted horse stables.

LIGHT CARRIAGES AND VOITURETTES

De Dions, Decauvilles, Darracqs—their name is legion. The owners of large cars are sometimes apt to despise the little



The Darracq Light Car

cars, as the driver of the four-in-hand disregards the pony-chaise. Some of these little cars are somewhat trying to people



Eight h.p. De Dion Light Car

with sensitive nerves. They have big single-cylindereed motors which run at high speeds, and their clatter is intense. But

they are frequently swift and easy to manage. The very light voiturette is giving way to the light car. Perhaps the most perfect model of the newer type is the 7 h.-p. Panhard. The 'tum-tum-tum' of its double-cylindere motor is by many considered a little objectionable, but otherwise the car is delightful. It may be said to be the direct outcome of racing.



Five h.-p. Renault Voiturette

Its top speed is thirty miles an hour, and it will average twenty miles an hour in any country. But far cheaper vehicles can be purchased which are sound and serviceable carriages. One costing 250*l.* ran without a hitch through the Automobile Club's Glasgow trial of 535 miles, and climbed the hills at good speeds. I cannot do better than refer readers to the

results of that trial, some of which will be found in the chapter on Records, and to the results of the club trials generally,



Delahaye Light Car

which may be obtained by the public by writing to the Automobile Club, London.

Light carriages known as *voiturettes* can be purchased for 120*l.* upwards, and many of them are good of their kind.



Seven h.-p. New Orleans Car

Assuming that the purchaser has 500*l.* to lay out, for that sum he can get a six or seven horse-power carriage with the Daimler type of engine, capable of carrying four people including the

driver, with a covered top for wet weather. Nay, if he is satisfied with a light and frail open carriage he could obtain one of much higher horse-power, and a speed up to between thirty and forty miles an hour ; but this is a mere racing machine for those who desire to travel speedily without any protection against the weather.

If the purchaser intends to run his car on economical lines let me advise mixed tyres, that is, solid tyres on the back wheels and pneumatic on the front. Although the speed is considerably reduced, a great source of expenditure is avoided. I am inclined to think that the pneumatic tyre craze has been



The 40 h.-p. Panhard and Levassor Racing Car which was driven by Mr. C. Jarrott in the Paris-Berlin race of 1901, and finished eighth

altogether overdone by motor-car owners. At the present time I am using solid tyres entirely on one car, on another mixed tyres, and on another, an American one, single-tube tyres (very excellent these); on yet another pneumatic tyres shod with metal, excellent for town use, and on a large and fast car, pneumatic tyres all through. The pneumatic tyres are undoubtedly the most comfortable of all, they are beyond question more speedy, but they are very costly—my own tyre bill last year was over 500*l*. They are also very liable to puncture in hot weather, more prone to cause side-slip, and in other ways a luxury that has to be paid for. I advance these points to prevent the purchaser from definitely

committing himself to pneumatic tyres because other people use them. I admit that the Michelin tyre is a beautiful piece of constructive work, still for some time past I have been gradually increasing the proportion of solid tyres in my stable.

In referring to horse-power, though I do not wish to encroach on the mechanical portion of this book, I would point out that to the lay mind the term is very misleading. It was thus that the earlier motor-cars were greatly under-powered. The average man imagined that a one-horse engine was equal to one horse, that therefore a six-horse was equal to six horses, and that a carriage propelled by six horses was good enough for anyone. The term horse-power is open to much misconstruction, it is very loosely used by manufacturers in their advertisements, and, as to advertisements generally, I advise considerable caution in accepting their statements. No manufacturer would decry his wares, and the statements of the leading firms of makers may, as a rule, be received; nevertheless, any person who has carefully considered the pages of advertisements in the motor-car papers will long ago have come to the conclusion that for ways that are dark the motor-car agent is, in some cases, a long way in advance of the horse-dealer.

A good motor carriage, of course, requires constant care and attention and skill. I was talking recently to the owner of several very good cars on which he had spent some thousands of pounds. They had been turned over to the care of a coachman, with the result that, though the poor fellow did his best, the vehicles began to be regarded as a mere nuisance. One would not dream of putting a coachman in charge of a printing machine, a steam launch, or a cathedral organ; yet each of these exquisite pieces of mechanism is as little associated with a stable and a coachman as a motor-car. Coachmen can be taught to *drive* motor-cars, but there is a great difference between mere driving and a mechanical comprehension of the machinery. In the case of the electric carriage, a shrewd coachman or groom can easily be trained to take complete charge.

A good many people interested in motor-car matters are

prone to the assumption that the motor-car question is a very simple one. To the horror of a good many of my enthusiastic friends I have always been bold enough to make two statements, first, that in unskilled hands the motor-car is very dangerous to its owner, its passengers, and others ; and secondly, that the motor-car is as complicated as the horse. In skilled hands undoubtedly the motor-car has no compeer ; it is a safer means of travel even than the railway. The chief danger is 'side-slip,' and in an article which I had the pleasure of contributing to the 'Badminton Magazine' I made the following remarks :

Personally I regard a twelve-horse power automobile as almost as dangerous as a four-in-hand. I object to driving behind a



Baron de Zuylen's six-seated 20 h.-p. Panhard and Levassor Car, which ran in the Tourist Section of the Paris-Berlin race of 1901

spirited team unless in proper hands. I refuse to drive in a motor-car unless I know the abilities of the driver. The automobile is free from the dangers that follow shying, bolting, rearing and running away, but it has an equally dangerous enemy in side-slip. Nearly every motor accident one reads of is an exaggerated account of a side-slip ; and yet nearly every side-slip is avoidable. Side-slip amounts to this, that one cannot rapidly apply the brakes on greasy wood, asphalt, oolite, macadam, or stone blocks. The result of such application is invariably unpleasant, sometimes dangerous. There are patent tyres which minimise the danger, but let every person who purchases a motor-car recognise that it *is* a danger, and one that cannot be avoided by the most skilful driver unless he proceeds slowly on dangerous road material.

The causes of side-slip are discussed by other writers in this book, but one cannot be too careful in touring, in mountain country especially, to watch the road material as one goes along, and to be ready at any time for very careful driving. There are certain conditions of some kinds of roads when it is almost impossible to drive a motor-car with safety even with non-slipping tyres.

An extremely bad piece of road on a very wet day, for example, is that into Cannes. Coming into Cannes from Marseilles there is a slight declivity just outside the Hôtel Beausite. I have driven up and down that piece of road many scores of times, but on one bad day I found it practically impossible to steer properly. Some of those roads in Kent and other parts of England in which the chalk surface has become exposed require careful negotiation. But the most dangerous road of all is during a partial thaw after a heavy frost. I can offer no suggestion for driving under these conditions. In the course of a winter tour during which one goes in a few minutes from green plains into half-frozen mountain roads, it is difficult to know how to continue one's journey. Mr. Mayhew, one of the best drivers in England, lately described in the gazette of the Automobile Club an experience in which he came rapidly backwards down a hill during a wintry run unable to exercise any control over his car. Fortunately, however, these incidents very rarely occur. I have made a three-thousand-mile journey in France without any occurrence of the kind; on the other hand, I have had a week of travelling on snowy and wet roads on which one had to fight against side-slip all day long.

Of the safety tyres it is yet too early for me to speak as regards their winter use. I have given them a trial on a heavy carriage, and the only objection I found is that they make a little noise when travelling over stone sets, and that they skid on snow. They certainly, however, enable one to stop instantly on surfaces where it would be impossible to check speed with pneumatic tyres. For this particular travelling-carriage I am describing, in the course of the description of which I have



GEORGES RICHARD 10-H.P. CAR
Without Chains or Belts



35-H.P. MERCEDES
With Kellner Body



LIGHT CAR
Hozier Engineering Co.



DURYEA MOTOR SURREY

FOUR TYPICAL MOTOR CARS

intentionally wandered to side issues, I have three sets of tyres, ordinary pneumatic, steel-shod safety, and solid. Each has its advantages. The pneumatic are obviously the most comfortable and the speediest, but they puncture easily and are prone to side-slip. The solid are much heavier and slower, but they do not puncture and are less liable to side-slip. The Gallus tyres are, I think, heavy, and do not look as though they would stand very long journeys at high speed, but they are very much safer, if costly. Still, I presume that those who are able to indulge in the somewhat expensive amusement of land yachting, which is, however, economical by comparison with the humblest kind of ocean yachting, will not hesitate at a few pounds in order to secure the comfort of safety. On such a tour stringent economies are not wise, though it is not necessary to be extravagant.

It would be grossly unfair to many excellent makers if I attempted only to support the Daimler and De Dion types of engines. Other good ones are in existence, and the next few years will doubtless see further developments. The danger to be faced by beginners is that they should be over-persuaded by enthusiastic inventors and makers to purchase a machine the description of which reads excellently on paper, which makes a very good trial trip, but which is of no real practical use. For this reason I would always urge that the actual purchase of a motor-car should be deferred until the last possible moment, until by experience and by enquiry real knowledge has been gained. For this purpose membership of the Automobile Club of Great Britain is a practical economy. Many automobilists have saved their entrance fee and subscription again and again by the opportunities offered by the Club of gleaning information. Other practical advantages of membership are pointed out elsewhere in this work, but I consider that in the present chrysalis state of the movement the opportunity of receiving unbiassed information such as is ungrudgingly accorded by one member of the Club to another is of the greatest possible assistance. Among its enormous

membership will be found owners of almost every known make.

To a man of leisure who is also of a mechanical turn of mind the management of a motor-car is doubtless a pleasure, but a very considerable amount of time is required for keeping the engine in order.

For some years I have made long Continental journeys in motor-cars, and have hitherto been exceptionally fortunate in avoiding breakdowns of any kind. My friends have been surprised at the punctuality with which we start in the morning and arrive at our destination, some two hundred miles off,



Twenty h.-p. Wolseley Car

in the evening. They are unaware that my engineers have spent at least an hour on each car before starting in the morning. Such care may not be necessary, but it is certainly wise.

One need not run to the other extreme of constantly tinkering with the machinery, a very common fault with amateurs. The desire to 'take the thing to pieces, put it together again,' and say afterwards that one has done so is very great.

The numerous difficulties of cars, the little things that happen, are ably dealt with in the other portions of this work, which should be carefully read by everyone before purchasing a

motor. My own experience is that a long run on a wet day in hilly country will, as a rule, find out what is wrong.

One must not on the other hand be too critical. In showing off a horse or a motor-car it not seldom, unfortunately, happens that neither is seen at its best. I remember in the summer of 1901 going for five months without a puncture of any kind in a certain twelve-horse car. I was punished for a little bragging by the occurrence of no fewer than three punctures one afternoon, while conveying a friend, to whom I had been congratulating myself, on a comparatively short journey.

Hardly any class of motor-car is so generally useful for country-house work as an omnibus. Wishing for something more speedy than an eight-horse Panhard, I purchased a twelve, and converted my old friend into an omnibus, which has proved eminently satisfactory for station work. Carrying four inside and one beside the driver, with ample room for luggage, it is a great relief to a horse stable in very hot or very wintry weather. It is geared down to twelve miles an hour, and pneumatic tyres have given way to solid. Were I ordering a new omnibus, I should not do so without at least a twelve-horse engine and seating capacity for ten, with luggage; and for heavy work in hilly country an even higher horse-power would be very desirable. My carriage was converted by an ordinary firm of London carriage-builders, who made no pretence of building lightly, and who were not aware that long journeys at twelve miles an hour will in time cause the windows to shake. These, however, are the only defects we have discovered in the converted carriage, which has frequently made journeys of a hundred miles a day with passengers and luggage. The form, of course, is not suited for long distances, as sitting sideways all day becomes very fatiguing.

There are now so many forms of covered vehicles that it is difficult to recommend one particular shape in preference to another. One form, however, possesses a danger with which I should like to deal. I refer to those carriages which are entered by raising the front seat, which have no other means of

entrance or exit, and in which the passengers are in a trap ; but it is difficult at present with the Daimler type of engine to have a satisfactory carriage by which one enters from the sides.

The most comfortable motor-car, and in many ways the most satisfactory, with which I am acquainted is my own Serpollet, modelled on the lines of the travelling-carriages of our grandfathers. It was specially designed for me by M. Kellner, senior, of the well-known firm of Kellner, Paris, who is old enough to have travelled across Europe in a genuine *Berlin*. I have made many long journeys on the Continent



Napier Car

in it. There is room for an engineer and valet in front and four passengers inside, though for long-distance travelling it is much more comfortable with only two passengers. The driver is protected from wind, rain, and snow by a glass in front, which may be raised if necessary, and by two side curtains. These front glasses have the disadvantage that they may become obscured by heavy rain, frost, or dust, and for this reason, under certain conditions of weather, they must be constantly rubbed over from the outside, as it is essential that the driver should be able to see distinctly. The

side curtains, too, have the effect of keeping out sound, which is a slight disadvantage, though considering that a motor-car is the most rapidly travelling vehicle on the road, the danger is not so much to be feared from behind as from something within sight. Over the driver's head is a wire luggage basket which conveys the heavier impedimenta of the tourists. Under the two back seats are locked drawers for valuables and anything that may be wanted *en route*. Under the front seat inside the carriage are electric batteries for the lamps with which the interior is lighted. The front seat can be let down if necessary, and its place taken by a net into which it is convenient to throw such things as books, cameras, a sponge-bag (containing materials for a hasty toilet on the road), maps, newspapers, fruit, and the hundred and one odds and ends one collects in a day's travel.

The material with which the interior of the carriage is lined is that pale buff cloth familiar to travellers in French first-class railway carriages. I feared that it would easily soil, but M. Kellner assured me that experience has proved it to be the best material, and he was entirely right; the carriage has now been running a year, it has been all over France and England, and it looks as good as new. The sides are a mass of pockets in which we stow all manner of unconsidered trifles. It is remarkable, indeed, what can be got in and upon a carriage of this sort; for, in addition to the personal belongings of the tourists, there are the engineer's and servant's spare clothes, and always a certain amount of special lubricating oil.

As the Serpollet boiler is heated by ordinary paraffin, we have not the petrol difficulty, for paraffin, or, as it is called in France, *pétrole ordinaire*, is procurable everywhere in almost any civilised or uncivilised country; indeed, it is as easy to obtain as water, which is, however, occasionally not so readily found as one might think—on the great plains of central France one may occasionally travel for an hour or two without being able to replenish one's water supply. My advice to travellers generally by steam automobiles is to take in water whenever they can,

and, so far as the Serpollet is concerned, the cleanest water they can get.

One of the electric lamps for lighting the interior of a travelling motor-carriage should be movable and have a long wire, so that it can be placed behind one for reading purposes, and be used for searching in drawers. I never allow the mechanical portion of the motor-car to interfere with the interior of the carriage, a rule which experience has taught me to be very necessary. Your motor-car engineer as a rule gives but little heed to the carriage part of his vehicle ; to him the engine is all in all, and he will not hesitate to thrust some of his oily belongings into the interior of one's vehicle unless such a rule as that which I have made is strictly laid down and sternly kept. So far as the outside of the car is concerned, on a long journey I do not go in for appearances, but I will not permit the inside to be disfigured with oily waste or black finger-marks.

The heating of such a carriage is not at all difficult to achieve by steam, but a very convenient warmer is known as the 'Instra.' It is, I believe, the invention of Lord Dundonald. It will be very well known to many readers as a small portable foot or hand warmer, consuming some form of charcoal. An ordinary carriage hot-water tin, however, does very well. Technically my carriage is known as a landaulet, and I am acquainted with no more delightful way of travelling in hot weather or indeed in winter. The advantage of such a carriage is that one is oblivious of the weather, and its only drawback (I do not refer to the Serpollet engine—that is dealt with elsewhere) is risk of side-slip.

As to touring, if one has a party it is pleasant to take two cars, one faster than the other. The fast one can be sent on ahead so that dinner and rooms for the night may be ordered.. It is never wise on such a journey to attempt too great distances in the course of a day ; personally, I am quite satisfied with a minimum of 120 miles, and in the short days of winter less is enough. To try a greater distance means very early rising or proceeding in the



PANHARD
With Kellner Body and Hood



5-H.P. RENAULT
With Kellner Body



MERCEDES
With Berline de Voyage by Jeantaud



SERPOLLET TRAVELLING CARRIAGE
By Kellner



ELECTRIC DUC
By Jeantaud



ELECTRIC SPIDER
By Jeantaud

SIX TYPICAL MOTOR-CARS

dusk on strange roads—always an unwise thing to do. My Serpollet can travel very easily twenty-five miles an hour on an ordinary give-and-take road, even when fully loaded. Faster than that is not comfortable and is not necessary. Averaging twenty miles an hour and allowing two hours for meals, exercise and sight-seeing, one finds that eight hours of a winter's day are gone when one's 120 miles are finished. In the summer, when touring is of course pleasanter, one can travel two hundred miles a day with the greatest ease and without discomfort.

A very useful form of motor-car is a beaters' or luggage-car, that is to say, a long wagonette. Mr. John Scott-Montagu has pointed out, in his interesting contribution to this book, the great utility of a car for conveying beaters or loaders. I would remark that such a carriage can also be used for conveying heavy goods and guests' luggage. It would not be difficult to get one made with an omnibus top for use if necessary.

There seems to be an impression that motor-cars should all be of a certain shape. The Tonneau body is at present the most popular. As a matter of fact one can get almost any shape one wishes, but experience has proved that forms of carriage which are suitable for horse-driven vehicles are not always equally suited to motor-cars. With certain kinds of engines, too, it is difficult to adopt any other form of car than the Tonneau, or for the wet weather the Limousine. Some kind of carriage bodies are obviously heavier than others, and, therefore, take away from speed, but I regard the suppression of mere open carriages for use in warm weather only as a matter of the very near future.

Though I am the possessor of one of the most powerful motor-cars in England, I am not at all an admirer of them for ordinary use. Even with what is known as the 'throttle' system of governor, by which one can reduce the speed as much as one wishes, I consider that these heavy and powerful road engines are a mere passing freak of the hour. Their weight makes them comfortable on rough roads, but the amount of petrol required to drive them is a serious item of expense. So

far as this country is concerned, there are very few roads on which they can, so to speak, be let loose. On the long, straight roads of France, it is pleasant to indulge in a sixty miles an hour spin now and then, but when one considers the rapidity with which these monsters consume tyres, the fact that they are not at all suited for the conveyance of ladies, and are most uncomfortable on wet, windy, or dusty days, I am inclined to think that a few years will see their disappearance.

Quite the most important point on which a purchaser should be satisfied is the hill-climbing power of the motor vehicle submitted to him. It is not only necessary that a car should take its full load up a steep hill, but it is essential for satisfactory touring that it should take its load up the steep hill at a good speed.

Many of the earlier cars were so under-powered (the engine-power being insufficient in relation to the weight of the carriage body and load) that on an incline of any steepness they could not pull their load at a speed of more than four miles an hour.

This matter is of urgent importance, and I propose to illustrate it very fully by showing the average speeds arrived at by one of these earlier cars and by a modern car respectively, over a distance of two miles, consisting of one mile up-hill and one mile down-hill.

If the old-fashioned car mounts the hill at four miles an hour and descends it at thirty miles an hour, its average speed for the two miles would be, in spite of the illegal and break-neck rush down hill, only a shade over seven miles per hour. If, on the other hand, the modern car goes up the hill at ten miles an hour and comes down at thirty miles an hour its average for the two miles will be fifteen miles an hour. At the foot of the descent the modern car would be nine minutes ahead of the old-fashioned car.

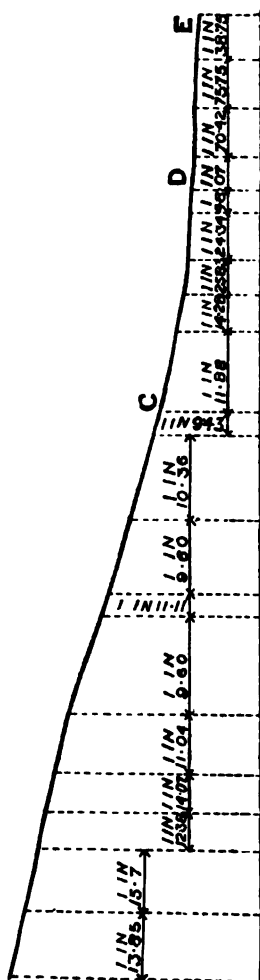
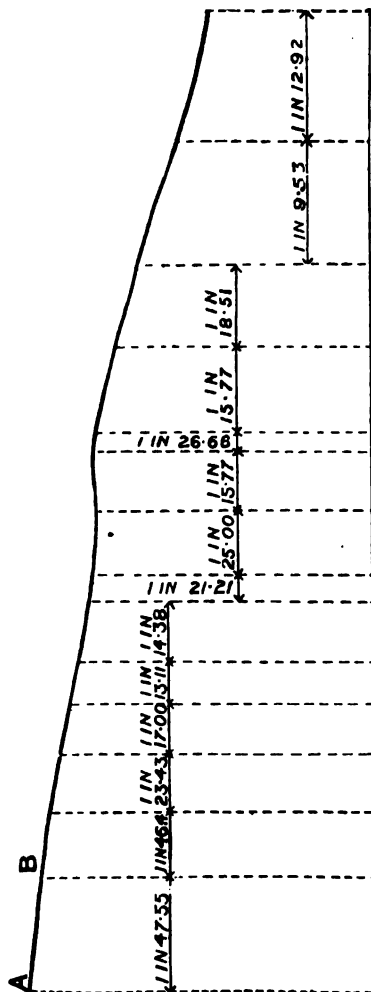
One may easily calculate what this difference would represent in a long day's run.

It is surprising to find that if a man who has been used to driving cars which go slowly up-hill changes to a high-powered car the temptation to rush down-hill vanishes. One's view of the road is reversed. Whereas in the under-powered car the temptation to rush down-hill came on one as a relief from the monotony of grinding and groaning up-hill, and consequently up-hills were dreaded and down-hills welcomed, with the high-powered modern car one pines for up-hills on account of the pleasure of annihilating them, and having arrived at the top the car is allowed to meander leisurely down the other side. Horses, bicycles, railway trains go slowly on up-grades. The modern motor appears to disregard the laws of gravity and to fly up-hill. The sense of conquest is glorious. The temptation to 'scorch' down-hill is gone. Undoubtedly the high-powered motor removes the temptation to excessive speed down-hill, and consequently removes a great danger. This is illustrated by referring again to our example. Supposing that the driver of the modern car wished to descend very cautiously, he could do so at six miles an hour and yet arrive at the foot of the hill a minute in advance of the old-fashioned car which ascended at four and descended at a speed of thirty miles an hour.

These illustrations will, I hope, bring home to buyers the necessity of purchasing a car which will ascend hills at a good speed, and of not being carried away by statements that a car will ascend 'one in four' without first ascertaining at what speed it will ascend 'one in ten.'

If a buyer finds that the car he is inspecting has not been submitted to the Automobile Club's 100 miles trial in which the speeds on hills are ascertained, he should insist on the seller carrying out a hill-climbing test in his presence.

Near London he cannot find a better ascent for this purpose than Petersham Hill, which leads from the Star and Garter Hotel at Richmond down to Petersham Road. The motor-car with its full complement of passengers should be timed from opposite the Dysart Arms in the Petersham Road,



Petersham Hill, Richmond

A. Junction with Queen's Road. B. Opposite main entrance to Star and Garter Hotel. C. Junction with Petersham Road. D. Opposite Fountain, Petersham Road. E. Opposite Dyart Arms, Petersham Road.

and the time should be taken again at the main entrance to the Star and Garter Hotel. This is a distance of 1,800 feet, having a total rise of one in fifteen, but at parts the gradient is as steep as 1 in $9\frac{1}{2}$. The following are the times taken by cars travelling at average speeds of from four to twelve miles an hour respectively between the Dysart Arms and the Star and Garter on Petersham Hill: 5 min. 7 secs. = 4 miles per hour: 4 min. 5 secs. = 5 miles per hour: 3 min. 24 secs. = 6 miles per hour: 2 min. 55 secs. = 7 miles per hour: 2 min. 33 secs. = 8 miles per hour: 2 min. 16 secs. = 9 miles per hour: 2 min. 2 secs. = 10 miles per hour: 1 min. 51 secs. = 11 miles per hour: 1 min. 42 secs. = 12 miles per hour.

As a matter of fact, the following results were obtained by experiments made during the winter when the roads were heavy between the Dysart Arms and Star and Garter entrance, with flying start:

A car costing 240*l.* and carrying 2 persons ascended at 8·8 miles p. h.

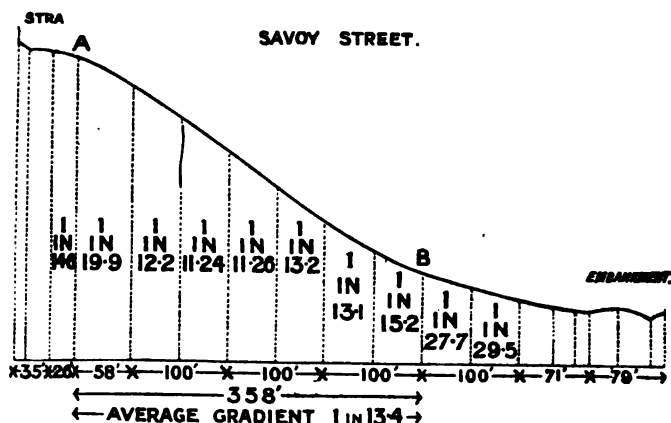
„	290 <i>l.</i>	„	4	„	7·8	„
„	328 <i>l.</i>	„	4	„	9·8	„
„	380 <i>l.</i>	„	4	„	10·8	„
„	450 <i>l.</i>	„	2	„	15·7	„
„	1,150 <i>l.</i>	„	4	„	16·8	„
„	1,150 <i>l.</i>	„	4	„	18·5	„

A contour of Petersham Hill is illustrated opposite.

Purchasers who live in hilly countries often ascertain from local surveyors what are the steepest gradients on surrounding hills. They then go to London to purchase a car and ask the makers if it will ascend 1 in $8\frac{1}{2}$. An agent has been known to say 'yes,' and, in proof of this statement, the purchaser has been driven up to Savoy Street and has been told it is 1 in $8\frac{1}{2}$. In order to assist purchasers, the engineer of the City of Westminster has kindly supplied a correct contour of Savoy Street which is published (p. 60), and from this it will be seen that the average gradient is 1 in 13·4 and the steepest is 1 in 11·24. Another hill, a really steep one, has also been specially surveyed for the purpose of this book, and the contour is published (p. 61).

This contour and the following particulars should be of considerable service to the purchaser from Devonshire or other hilly districts, and also to the maker of a good car, as the latter can prove by demonstration not only whether the car will go up a hill of known gradients but—a very important consideration—at what speed it will go up the hill.

The ascent to which I refer is situated in Richmond Park, and is usually known as the 'Test (or Broomfield) Hill.' On entering the Robin Hood Gate, the first turning to the left

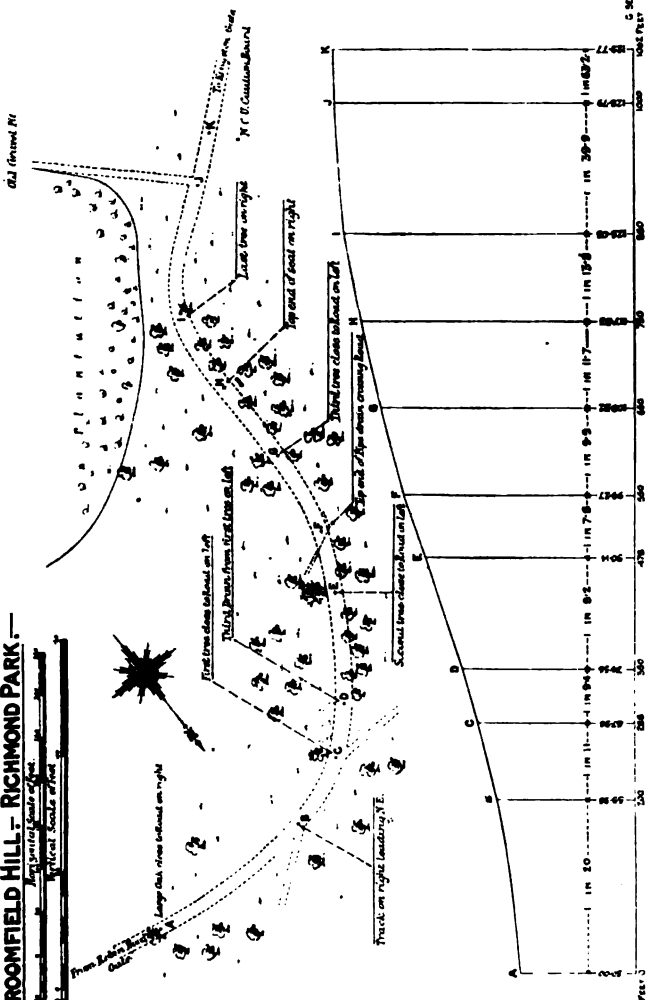


should be taken. A gradual and winding ascent leads to the foot of the steep portion. Time should be taken on passing the second of two oak trees on the right,¹ the branches of which completely overhang the road. Time should also be taken at the last oak tree on the right at the top. The difference of altitude between these two trees is 75.03 feet. The average gradient is 1 in 11.3; and there are 72 feet having an average gradient of 1 in 7.8.

The following table shows the times taken by cars travelling

¹ Marked A on plan.

BROOMFIELD HILL:- RICHMOND PARK.—



at average speeds of from four to twelve miles an hour respectively between the two oak trees above-named on the Test Hill in Richmond Park :—

2 min. 25 secs.	=	4 miles per hour.
1 min. 55 secs.	=	5 ,,
1 min. 36 secs.	=	6 ,,
1 min. 22 secs.	=	7 ,,
1 min. 12 secs.	=	8 ,,
1 min. 4 secs.	=	9 ,,
57 secs.	=	10 ,,
52 secs.	=	11 ,,
48 secs.	=	12 ,,

The following speeds were attained in experiments held on the above-mentioned portion of this hill during the winter. The cars had flying starts :—

A car costing 290/. carrying 2 persons ascended at 8·5 miles per hour.

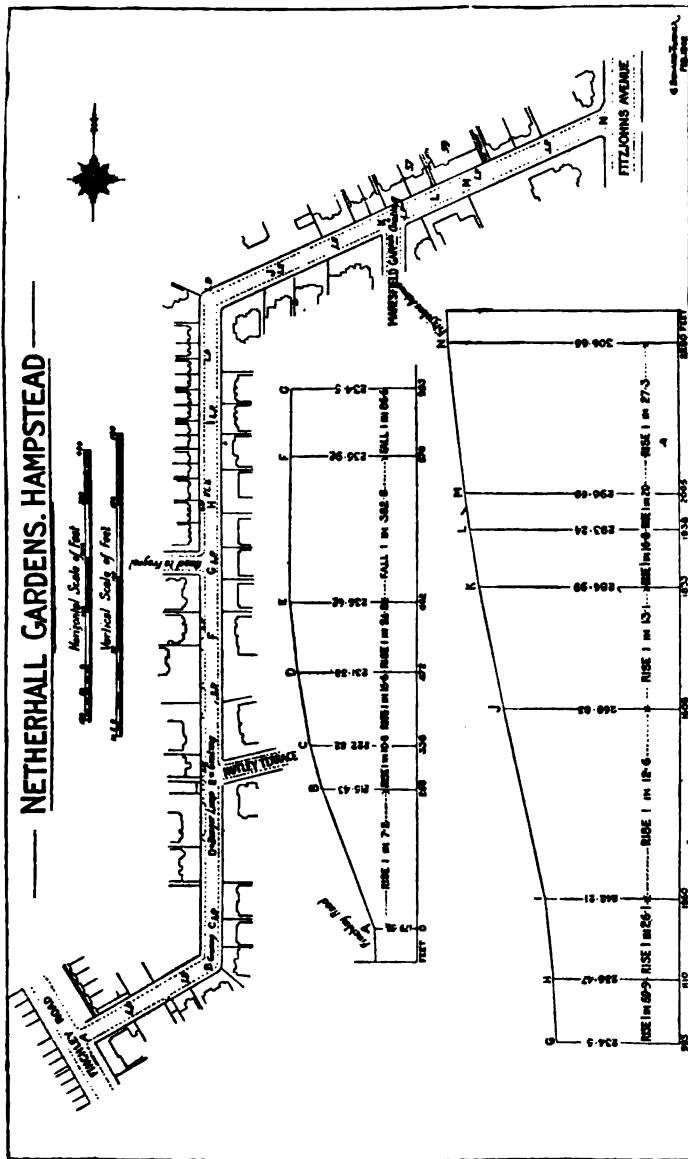
„ 380/.	1	„	10·9	„
„ 450/.	2	„	14·4	„
„ 1,150/.	4	„	15·2	„

Another hill which is fairly convenient to London, and is often used to test cars, is Netherhall Gardens, leading out of Fitzjohn's Avenue, near Swiss Cottage Station. This hill has been specially surveyed for the purpose of this book, and a contour is shown opposite.

PARAFFIN MOTORS

Many readers of the 'Badminton Library' will desire to know of cars which can be used where petrol is unobtainable. Messrs. Roots and Venables in England, Koch and others on the Continent, have for a long time studied the problem of the paraffin internal combustion engine. The advantages of motor-cars fitted with these engines for use in hot climates and places where petrol cannot be purchased are obvious. Ordinary lamp-paraffin can be found in almost any part of the globe.

NETHERHALL GARDENS. HAMPSTEAD



A. Line of Forecourt fence east side of Finchley Road. B. Drain-grating in the middle of bend. C. Opposite first lamp-post (L.P.).
 D. Danger lamp in the middle of the road. E. Grating. L. A point in centre of road opposite the party fence on the left between
 Nos. 57 and 59. N. The kerb-line on the west side of Fitzjohn's Avenue. P.L.B. Pillar letter-box. L.P. Lamp-post.

MOTOR-CARS FOR DOCTORS

Motor-cars will before long be used by all doctors whose practices involve much road travel. The question of cost is the important one. Space does not permit of this being dealt with here, but the question was very fully discussed in a nine-page article which appeared in the 'Autocar' of October 7, 1899, p. 888, and to a smaller degree in the same issue on p. 907; also in the 'Autocar' of October 14, 1899, p. 921, and December 8, 1900, p. 1189.

Many doctors who use motors have joined the Automobile Club, and these are always willing to give information to their fellow-members.

SECOND-HAND CARS

I do not advise the purchase of a second-hand car, but if it is considered necessary to effect a very doubtful economy I urge attention to the following points:—

(1) Pay no attention to paint, varnish, and upholstery. These things cost a few pounds only, and often hide a multitude of defects.

(2) Insist on a whole day's trial on a hilly road.

(3) Let the engine be taken to pieces after the trial, to ascertain condition of cylinders, gear, and bearings. Should the cylinders prove to have been heated on any occasion drop the idea of purchasing the car. Cylinders are often covered with aluminium paint to hide this fatal defect.

(4) See that the axles are straight and that the four wheels run true and parallel.

(5) Ascertain number and type of engine, and write to manufacturers for real date of issue.

(6) In buying a second-hand electric car look carefully to the state of the batteries. Batteries, like petrol engines, can be 'faked.' Let batteries be discharged through a recording voltmeter and amperemeter, and see that the amperage of

discharge is equal to the force required for running the car on a level road. See that the commutator is not worn.

(7) Second-hand steam cars of American make are worth little. Beware of them. Second-hand Serpollets are probably out of date. There are many about, and my experience proves them to be worthless. In the new type (issued since September 1901) see that the boiler tubes are in good order, and have not been scraped for effect. See also that there is no play on the bearings of the cam shaft.

(7) Generally speaking, approach second-hand cars with grave suspicion. My remarks will be unpalatable to dealers therein, but this book is not written for them. It would be grossly unfair to a respectable body of tradesmen to stigmatise them as dishonest, but there are unfortunately many black sheep in the fold.

MOTOR ENGINEERS

A prime difficulty of the establishment of a motor-car is the chauffeur or engineer.

The perfect motor servant should be a combination of gentleman and engineer. He is a new type of man, and will require the wages of other engineers. I do not think that a competent, cool-headed, skilful, well-mannered engineer will ever be obtainable for 30s. a week. On the other hand, the simplification of the motor engine and the establishment of *garages* will render the employment of highly educated engineers unnecessary in private establishments. As to public *garages*, some are well managed, others are not. Beware of those which offer to house your car very cheaply. They will make up the deficiency by overcharging you for repairs.

CHAPTER IV

DRESS FOR MOTORING

I. DRESS FOR LADIES

BY LADY JEUNE

My simple task in this volume is to discuss that side of the question which affects women very deeply: how to dress and equip themselves so as to be warmly and comfortably clad with as little disfigurement as possible. The fact that women should motor—if a verb may be employed—and care for it as much as they do is a great tribute to their lack of personal vanity, for, try as hard as they can, it is almost impossible to make the dress they have to wear a becoming one. In most of the sports and pastimes of women the dress they assume is arranged with a view to adding to their charms, and in nearly every case it can be both pretty and serviceable. In croquet, lawn tennis, skating, hunting, driving, or bicycling, the dress worn by women may be excessively becoming, as it can be made to show off the figure, and the hat or headgear is generally a delightful frame to the face—indeed, the fact that the athletic costumes of women are so picturesque is possibly one of the reasons which have made out-door sports so popular among them.

In the case of motor driving or riding there are two things only to be considered: how a woman can keep herself warm in winter and not be suffocated by the dust in summer without making herself very unattractive. Dress must be regulated

to a great extent by the speed at which she travels, and it is quite possible to wear a smart hat and pretty clothes if the pace is a comparatively slow one, such as is usual in the Park or in the streets of London. This chapter, however, has to deal with the more serious side of the question, how a



A long Coat showing Leather
Waistcoat



The same buttoned up

woman should dress who goes on long journeys in every kind of weather, and at a high rate of speed.

The first consideration must be to keep warm, and the second – a no less important one—what head-gear must be worn

that will keep on the head, and not be blown off by the first gust of wind. The question of warmth must be considered from every point of view, and plenty of suitable clothing is absolutely essential. A warm gown should be adopted, made of a material that will not catch the dust, and it is also important to wear warm clothing under the gown ; for unless such jerseys and bodices are worn, the wind penetrates, and it is quite impossible to avoid feeling chilled during a long day. The fatigue which is inseparable from many hours in the open air, and is also intensified by the rapid speed at which one travels, becomes greater as the day passes ; with the increase of that fatigue a feeling of cold arises, so that unless a sufficient amount of warm clothing is worn the sense of exhaustion becomes very trying.

The best material for excluding the cold is leather, kid, or chamois leather ; the latter may be recommended for lining the coat, and kid for the outside covering. This has, however, the disadvantage of being heavy and stiff, while chamois leather is softer and gives the figure more laxity. A coat lined with chamois leather and fur is the most successful of any, and the outside cover can be made in any pretty waterproof material.

The best coats that I have seen for motor-car driving are some which come from Vienna, and are both cheap and comfortable. The fur employed for the lining is opossum, which is both light and thick ; they are to be had of any length, they button up the front, are double-breasted, and have two warm pockets placed crossways in front. The coat of which an illustration is given is excellent for the purpose, but it is more elaborate. It has, however, the leather waistcoat or undercoat attached to it, and is extremely comfortable. It can be made in any cloth or material. It has heavy fur which, while it looks smart, is a sure means of catching and retaining dust, and the great object to be aimed at in motor travelling is to find something which will not collect dust, for if coats, rugs, &c. get dusty it is almost impossible to get rid of it. The

longer a coat is the better, for it is round the extremities that the cold is felt as much as anywhere. Therefore a coat should be made loose enough to wrap round the figure and fold well over the knees. It is quite impossible to keep warm in a rapid motor journey except by using fur rugs, and they should be backed with leather, which mitigates the trouble of beating the dust out of them at the end of the day.



Glengarry Cap

Difficult as it is, however, to keep warm and fairly clean as regards the clothes which should be worn, the real problem is how to keep a hat on. The head must be warmly covered and the hat small, for anything large or wide offers too much resistance to the wind, and gets quickly blown off. After many experiments I am satisfied that the picture given above shows the best head-dress for the motor-car. It is a blue Glengarry

II. DRESS FOR MEN

BY BARON DE ZUYLEN DE NYEVELT

President of the Automobile Club de France

WHEN I asked why I had been invited to write on this matter I was told that it was because I had toured on my motor-carriage in many parts of the Continent, had met automobilists from many countries, and thus had had peculiar opportunities of picking up hints as to dress. It was added that in addition to this, as I am in the habit of spending a part of every year in England, I was in a position to know what would and what would not be acceptable to British gentlemen.

The dress worn by many motorists has been the subject of much irreverent ribaldry, and it must be conceded that, in many cases, the chaff has been merited. It is difficult to imagine anything more grotesque than the appearance of some whose enthusiasm makes them forgetful of their appearance. However, in order to drive with safety to the health in an open automobile, special garments are necessary. Clothes which may be quite suitable for a drive in a dog-cart are altogether unsuitable for use in an open motor.

When driving at twenty miles an hour the wind will actually pass through tweed overcoats and cloth garments; the air will be felt whistling round the ribs, and coats become distended behind like balloons. Speaking generally, therefore, the first requirement of motor clothes is that the stuff of which they are made should be air-proof, and the second that they should be so contrived as to prevent the wind from getting under them. A leather jacket and leather trousers are objectionable because the moisture from the body cannot escape, with the result that underclothing becomes dangerously moist and disagreeable. Leather may, however, be used as a lining to cloth clothes, provided that it is bored with many small holes through which

the moisture of the body may evaporate. A suit of cloth lined with punctured chamois leather will be found agreeable for both winter and summer. As most men like their clothes to be so fashioned that there may be nothing remarkable about them if they call on a friend, I find that men frequently have their motor suits cut in the ordinary way, Norfolk jacket or short coat with trousers or breeches and stockings; but the coats have one unnoticeable but very important provision, viz. they are so made as to button tightly round the wrist. Unless this precaution is taken it will be found that the cold air will blow up the sleeves, with the result that the hands, arms, and even body generally, will be made very cold. If the automobilist does not use a thick rug to protect his legs, gaiters should be worn with knickerbockers, and, if trousers are worn, they should be bound tightly round the ankles when driving. As regards underclothing it should be borne in mind that silk is perhaps the best material for retaining the warmth of the body.

We have next to consider the matter of overcoats. On the Continent a coat made of rough fur is worn, with the fur outside. It is found that, in addition to the heat-retaining qualities of the fur, such coats have the advantage of readily shooting off rain and of drying very quickly after a shower. They are provided with very high collars, which in cold weather are turned up, and almost surround the head. These coats have been a source of very considerable amusement to on-lookers and small boys in England, and it is a question whether they will be generally adopted; Englishmen appear to prefer a coat of Melton cloth lined with fur inside and fitted with a high fur-lined collar. Probably this garment fulfils all the purposes of the coat in which the fur is worn outside, and at the same time is less conspicuous. Moreover, it is held that the fur being interposed between the ordinary coat and the great-coat, permits of a certain amount of healthy ventilation.

In the summer, when the weather is very hot, provided that a thick suit of clothes be worn, a great-coat is sometimes unnecessary, except as a protection from dust. A light dust-

coat, made of a dust-coloured material and fitted with a high collar, will then be found useful, as after a dusty drive it may be taken off, and the ordinary clothes are left unsoiled. A light silk handkerchief tucked in over the collar is necessary to prevent the dust from working in around the linen collar and marking it.

Capes should be avoided, as more than one bad accident has arisen from a cape blowing up in a driver's face and thus temporarily blinding him, with the result that he has driven his car into the ditch. At the same time it is recognised that the best garment for protection from rain is that which most closely approximates to a bell tent. A coat is apt to let in water at points where the fabric is stretched; for instance, at the elbow. A tent-shaped coat on the other hand is not stretched at any point; consequently the water runs off it.

An English firm has made a clever adaptation of this bell-shaped garment by turning out a coat made of waterproof Melton cloth, which is in the form of a long cape reaching down below the knees, and very full in the skirt. It is fitted in the front with short sleeves, through which the hands are placed, and in which the wrists rest; so that the hands are free to deal with the steering-wheel and speed-levers, at the same time the arms and elbows are thoroughly protected, and the cape-shape is maintained.

Many drivers object to using rugs, for fear that, inadvertently, the tail of the rug may work underneath the clutch or brake pedal. An automobilist will recognise at once that very dire disaster might result if he were suddenly to find himself unable to release his clutch.

A Parisian tailor who has specially studied motor clothes, recognising this danger, has designed a very ingenious rug, which is split in two, the two halves being so devised that each wraps round the leg, and is fastened at the bottom so as to form a fairly tight outer covering to the leg, with a rug-like wrapping round the body.

A London tailor has also recently made an excellent

and efficient rug which may be used with safety for motor-driving.

A Piccadilly tailor, again, is building a special motor-coat, which obviates the necessity for a rug by being cut very wide in the skirt and buttons at the side. The garment is of good appearance, and somewhat resembles a German officer's great-coat. The motorist, therefore, has a choice of serviceable attire. One of the disagreeables of a long drive through rain is that the water is apt to accumulate on the seat of the carriage, so that its occupants are virtually sitting in a small bath. I was amused to see some correspondence on this matter in the 'Automobile Club Notes and Notices' of February 4, 1901, No. 32, p. 197. Mr. T. G. Carew-Gibson there gave the following amusing account of a device in common use in the back country of Australia by coach-drivers and others :—

It consists of a flat, circular, leather-covered cushion about 15 inches diameter, by, say, 2½ inches thick, having a hole 2 inches or 3 inches diameter right through the centre. In fine weather you sit on the cushion, which—the coefficient of friction between trousers and cushion being greater than that between the cushion and coach seat—does all the sliding about (N.B.—the coaches are hung on thorotraces instead of springs), and saves both person and garments from considerable wear and tear.

In wet weather you put the cushion *inside* your coat before sitting down, and thus preserve a dry seat. Should you at any time leave the cushion exposed to rain, the water will not form a pool in the centre and saturate it, but will run away at once through the hole.

Just after the break-up of the 1888 drought, I, one day, struck the salubrious township of Booligal, in the Riverina District of New South Wales, and about 4 A.M. next morning, in a nice steady rain, issued forth from the 'hotel' to take my seat on the coach bound for Hay.

A minute later out came an old bagman who had also camped there, and seeing the driver standing dripping under the verandah, whilst the five lean and drought-stricken horses were being yoked up, asked him to wait a minute whilst he went across to the store. He shortly returned and climbed up beside us on the box, having

under his arm a cheap American cloth table-cover, of a brilliant orange hue, and ornamented with a chaste design in bright pink flowers, and also a large gridiron, a fine specimen of the kind which stands on four short legs and has a long handle. He first proceeded to break off the handle of the gridiron, and remarking that he always liked to keep a certain portion of his anatomy dry, placed it on the seat and sat down on it: then borrowing my knife, he dexterously cut a slit in the exact middle of the table cover, through which he passed his head, observing that now he didn't care a ---- when we got to Hay.

One of the principal waterproofers in the City of London has devised a kilt made of strong indiarubber material which is absolutely waterproof. This kilt is worn high round the waist, buttons down the side, and reaches below the knees. It is intended to be worn with gaiters, and under a great-coat. If the driver's seat becomes a pool of water the wearer of this kilt remains in blissful ignorance of the fact. Furthermore, the draining of water from the front openings of the coat—which is apt to take place at the point where the legs bend from the body—is shot off by means of this kilt. It has this advantage also, that in very cold weather if it be found necessary to alight from the carriage to make some adjustment, the hot envelope of air is still retained under it. On the other hand, if the driver be using a rug, he finds it necessary to throw it on one side, and to expose his warm legs to the cold air.

Snow Boots—viz. boots having indiarubber soles and cloth sides, which are made to slip on over other boots—will be found invaluable for motor-driving in cold weather.

Hats.—As to the matter of head-dress, it must be at once admitted that the peaked cap which has found so much favour amongst the chauffeurs on the Continent is not adopted, and, I think, never will be adopted, by British gentlemen for motor-driving. The Englishman appears to have a horror of anything approaching a uniform; or, in fact, of wearing anything which would draw the eyes of people upon him. Officers in the army and navy never wear their uniforms except when

they are compelled to do so, and after levees it is amusing to see the Briton crouching down at the back of his carriage, and driving to the nearest club, in order to get into mufti at the earliest possible moment. Almost the only time at which he indulges in a uniform is when he is on his private yacht, and free from the gaze of the crowd. He then wears a distinctive dress, with which the peaked cap is associated, but, so far as the roads are concerned, the peaked cap is only seen on the heads of the drivers and conductors of electric tram-cars, &c. The consequence is that the peaked cap is becoming recognised as the proper head-dress for a motor servant. The motor owner, on the other hand, as a rule wears precisely the same hat as he would wear for shooting, golfing, fishing, and other outdoor sports—viz. the cloth cap, or soft felt hat.

Gloves.—For driving in cold weather, it should always be borne in mind that the gloves should be very large, so that when the hand is bent to grasp the steering-wheel the circulation may not be impaired by the veins being partially closed owing to the tightness of the coverings. Furthermore, a loose glove allows of a cushion of warm air to be formed between the hand and the outer cover of the glove.

Gauntlets are worn by some motorists in order to prevent the wind from getting up the sleeves of a coat.

Goggles.—The goggles, or glasses surrounded by silk or some other material, which are worn by motorists are, as a matter of fact, almost indispensable. In the winter, driving in the cold with the eyes unprotected is apt to cause inflammation. In the summer, the dust arising from other vehicles is a source of considerable danger to the eye, and has been known to bring about granular disease of the eyelids. Furthermore, when driving at high speeds the blow of a small fly, let alone a bee or a cockchafer, on the eyeball is enough to cause temporary blindness. Silk or other material is attached to the glasses in order to prevent particles of dust, small insects, &c., from drifting in under the glasses. In winter it is found

desirable that the material attached to the glasses should hang down as low as the mouth, and thoroughly cover the temples and cheeks if the motorist should be inclined to neuralgia.

Generally speaking, there appears to be no reason why, apart from the goggles, a motor owner cannot dress in such a manner as thoroughly to protect himself from cold and at the same time retain so ordinary an appearance as to avoid public attention.

CHAPTER V

MOTOR-CARS AND HEALTH

BY SIR HENRY THOMPSON, BART., F.R.C.S., M.B.LOND., &C.

IT gives me particular pleasure to contribute to a book on automobilism, inasmuch as I am old enough to remember the steam coaches which were running in London in the third and fourth decades of the last century, and, at the age of nearly eighty-two, I am taking part in the revival of automobilism, and am in the habit of making journeys almost daily in my automobile.

I am asked to write concerning the relation of driving motor vehicles to health. Personally, I have found my drives to improve my general health. The easy jolting which occurs when a motor-car is driven at a fair speed over the highway conduces to a healthy agitation; it 'acts on the liver,' to use a popular phrase, which means only that it aids the peristaltic movements of the bowels and promotes the performance of their functions; thus accomplishing the good in this respect which arises from riding on horseback. Horse-riding has, however, the advantage of necessitating exercise of the muscles of the legs. This is one of the disadvantages of motoring, but I have found that it may be to some extent overcome by alighting at the end of a drive of twenty miles, and running smartly for about two hundred or three hundred yards. I make this a practice in relation to my motor drives. Remaining seated in one position, with little or no opportunity of moving the lower limbs, renders them very liable to

stiffness or cramp, especially in the case of elderly drivers, whose joints are less mobile and flexible than those of the young. The exhilaration which accompanies driving in a motor is particularly helpful to people who are somewhat enervated. I have known instances of ladies suffering from defective nerve power who have derived great benefit from the invigorating and refreshing effect of meeting a current of air caused by driving in an automobile. Veils of varying thickness, according to the temperature, should of course be worn by ladies, but much of the benefit to nervous patients is caused by the air blowing on the face. The facial nerves are acted upon with beneficial results well known to have a restorative influence on weak and so-called 'nervous' individuals.

Furthermore, the action of the air on the face, and the continual inspiration of fresh air, tend to promote sleep, and I should have no hesitation, speaking generally, in regarding daily exercise in a motor-car as aiding towards the prevention of insomnia.

To dwellers in cities the automobile is of great benefit, as it enables them in a short time to reach the fresher air of the country. It is difficult to exaggerate the necessity for those who live in the densely populated parts of cities and large towns to take every possible opportunity of breathing the purer air of the country. The air in towns is impregnated with carbon (smoke, i.e. particles of unburnt fuel). It is also, in dry weather, loaded with dust, a great part of which is composed of dried and pulverised horse manure. In wet weather, fluid manure from the same source is absorbed by and then exhaled from the road or wood pavement, with similarly injurious effects. These impurities are practically absent from the air of the country, and so access thereto is one of the great benefits which may be derived from the use of the automobile. I look forward to the day when Mr. Arthur Balfour's hope may be fulfilled—viz. when the perfected automobile will provide rapid and cheap transit for workers in cities to healthy homes in the country.

I have been told by men who are occupied long and closely with brain-work, that the automobile has filled a great want in their lives. They have found themselves too much exhausted to be able to take a long bicycle ride into the country ; while railway travelling excites their overwrought nerves, and increases their sense of fatigue. The effort to catch a train at a definite time is in itself irritating and wearing to an over-worked system. No such effort is necessary to the owner of a motor-car who has a trustworthy driver to relieve him from the mental labour of watching the road, since he need have no fixed time for departure, but may call for his car whenever he is ready, or feels inclined to start. A drive behind a horse scarcely amounts to a recreation after the turmoil and worry of his work.

In the automobile, however, he finds ample sources of interest, amounting sometimes to a gentle and healthy excitement with complete rest and absence of fatigue from muscular exertion ; without the bustle, noise, and sense of confinement which accompany railway travelling ; together with the refreshment of novelty and suggested ideas occasioned by the contemplation of a continually changing panorama of scenery ; at the same time enjoying the recuperating effect of breathing the fresh country air. One enormous advantage of automobilism lies in the fact that it is so admirably qualified to supply recreation for the modern worker.

Now let me give a few words of caution. The vigorous man who has been used to take exercise on horseback, on his bicycle, or on his legs, must beware lest the fascination of motoring lead him to give up his physical exercise. Unless he systematically maintains habits of muscular exertion he may find that he is putting on flesh, becoming flabby, and generally losing condition. Whether he possesses a motor or not, he must use his muscles regularly and sufficiently if he desires to preserve his health. The eyes also should be carefully protected by glasses with silk attached to them partially covering the cheeks, whereby the small flies and dust which

accompany road travel in the summer-time, and the cold winds of winter, may be excluded. Dust may set up irritation in the eyes and cause serious trouble, while driving in cold weather with the eyes unprotected may lead to similar conditions. It is a very good plan on returning from a dusty drive to wash the eyes by means of an appropriate eye-glass with a weak solution of boracic acid. Any respectable chemist can supply a solution of the proper strength to be used diluted with warm water. I always have a solution at hand in my dressing-room for the purpose.

Another chapter in this book deals with the question of dress, but I should like to impress upon those who adopt the luxury of motoring that it is better to be too warmly clad than insufficiently clad. A drive when one feels cold and fatigued may result in 'a chill,' which usually means a cold or cough more or less severe. Those who are learning to drive should be careful not to be out for long periods whilst they are beginners, as the strain of driving may cause unnecessary and harmful exhaustion. When, however, a driver becomes familiar with his car and driving becomes automatic this exhaustion entirely disappears. Of this, I must admit that I have no experience, having invariably relegated all the management of my car to an experienced driver, and reserved to myself the freedom of enjoying the incidents of the road and the scenery—may I say, *otium cum dignitate*?

CHAPTER VI

THE MOTOR STABLE AND ITS MANAGEMENT

BY SIR DAVID SALOMONS, BART., M.A.

AT the present time probably not one per cent. of the owners of motor-cars have a suitable coach-house for this new class of vehicle. They are generally placed in sheds or outbuildings, more often damp than dry, or in coach-houses built for horse-drawn carriages. Few recognise that the motor-car is a far more delicate article than the horse-drawn carriage, most people having grown up in the common belief that anything to do with machinery is strong, and will bear knocking about. It is well, therefore, at once to disabuse the mind of such ideas.

The abode of the horseless carriage requires to be superior in many respects to the shelter given to the machineless vehicle. It must not only be perfectly dry, but must have a variety of accessory arrangements for dealing with all parts of the machinery—for cleaning, adjustment, and repairs. A water supply, and a source of light safe in the presence of explosive gases, are essential. The space must not be too cramped, and plenty of light should be obtained through ample windows during the day.

The machinery must, from time to time, be examined from below. This can be effected in one of three methods :—

(1) By the attendant lying on his back under the carriage, a proceeding which does not commend itself.

(2) By a specially arranged platform, wherewith the carriage can be raised from the ground to enable a man to get below the vehicle without discomfort.

(3) By means of a pit sunk in the ground, by which a man finds himself comfortably situated below the car. This pit may be small, and the carriage gradually advanced in order to reach all parts of the machinery, or, what is best, it may be a long pit, so that the car can be examined throughout its length. This method will be evident to all as the best.

A well-built motor-house should cost nothing in the upkeep, beyond the painting of the doors occasionally. A cheaply built motor-house implies an annual expenditure combined with vexation, and after a few years a patched-up place is the result.

The writer has given great attention to motor stables. It may not be out of place, therefore, if the methods adopted at Broomhill, near Tunbridge Wells, are described in detail.

The stabling consists of five long narrow rooms, one made to contain three small cars, another two large ones, the third two small or one very large car, the fourth room a small car, or may be used as a cycle house; and the fifth room will accommodate two moderate-size vehicles, or can be used as a washing-house in bad weather. One of these resting-places is somewhat modified to enable repairs to be carried out.

This latter house will be described, since, if only one shelter existed, it should be so constructed. It is twenty-eight feet long, ten feet six inches wide, walls eleven feet high. The whole construction is fire-proof, with the exception of the ceiling, which is tent-shaped and match-boarded, having a long skylight on the north side in order that the direct sunlight may not enter. The skylight is Mellow's patent glazing, which never leaks and does not require to be painted. The glass is one quarter of an inch thick to resist a hailstorm. Some years ago a hailstorm of extraordinary violence occurred around Tunbridge Wells, and glass to the extent of thousands of pounds was broken throughout the district. Many of the hailstones measured over an inch in diameter. The experience at Broomhill was that all glass a quarter of an inch thick

escaped, and this was a lesson learned for the future. The skylight is barred, to keep out evil-disposed intruders, and a tick blind can be pulled down to subdue the light when required. There is no special object in making the roof fireproof, since the side walls are high. The entrance doors consist of a pair, practically the whole width of the house. Collinge's hinges are used, being, I think, the strongest.

The floor is made of Victoria stone laid on brick sleeper walls, which are not built upon the ground, but upon a six-inch bed of concrete covering the whole of the bare ground. Consequently the floor can be kept perfectly dry. The walls are all double nine-inch brickwork, built in cement, with two inches of air-space between; so that, however wet the weather may be, the interior wall is never damp; and they are carried above gutter level so that any fire may not extend. The bricks employed for the interior and exterior are neatly pointed close-grained white brick having a texture the nature of porcelain, and water-proof. For the interior, cemented walls would have answered the purpose, but the pointed brickwork looks better. The roof is boarded, felted and slated, while below the rafters is a lining of matchboard. By this means the roof is as damp-proof as the walls and floor. This method of building is best adapted to keep out variations of heat and cold, since stationary air is an excellent non-conductor. The only escape for heat is through the skylight, but in very cold weather it is only necessary to pull the blind down, and an equal temperature can be maintained.

In the centre of the floor, and extending almost the whole length of the house, is the pit, which is about eight feet deep. This is made excessive in depth for a reason which will be given in due course. The width of the pit is somewhat narrower than the distance between any of the motor-car wheels. The mouth of this pit is a strong timber frame, the wood being four by three inches, and rabbetted the whole length of the two inner sides. Boards two inches thick and two feet wide drop in the rabbetts, each board having sunk

iron rings on the surface. The object of this arrangement is that when all the boards are dropped into place the pit is completely closed, and by means of the rings any one or more covers can be raised as required, in order to open the pit for an observation from below.

The chief object to be attained by building several separate motor-houses in the place of one large one is that wall space is gained, which is a matter of no small importance when it is remembered how many spares are required in connection with motor-carriages. The walls of the motor-house under description are furnished in the following manner. Near the doors on either side are ranges of small shelves upon which are placed the most necessary tools and other small items which are almost invariably required when a carriage is to go out. The remainder of the wall is furnished with larger shelves to carry testing apparatus, pumps, a variety of tools, and such spare parts as are not carried in the vehicle, as well as oil, &c. There are also brackets of metal or wood, in the shape of the arc of a circle, upon which are hung spare covers and air tubes. There also exists a small chest of drawers, each drawer being divided, such as those used by watchmakers to contain small parts in an orderly manner.

This house is prolonged beyond the space necessary to stand the carriages, to the extent of about six feet.

This space is occupied by a work-bench, vice, and hand-drilling machine, and upon the end wall are racks for all the tools necessary for making small repairs, and a complete set of duplicate keys, so that when the adjustments are made it will not be necessary to turn out the contents of the car. There is likewise apparatus suitable for soldering and brazing by gas or by benzine lamps, the gas being used when there is no danger, while in the other case the benzine lamp is employed outside the motor-house so as to be in the open air.

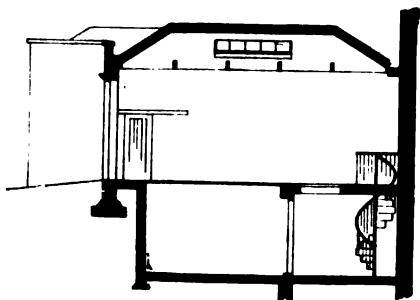
In the corner, by the side of the bench, is an iron circular staircase which leads down to a small basement, lighted by a glass in the motor-house floor, where large spares are kept, and

any special tools &c. which are rarely required, such, for instance, as a grindstone, also large reservoirs of oil. This basement has a door which leads into the pit. It will now be seen why the pit is made so deep, since it can be entered without obliging anyone to stoop, the doorway leading into it being the usual height, viz. about six feet seven inches. In order to reach the cars conveniently two trestles are provided in the pit, across which are placed also some narrow planks, and there is a small pair of steps for reaching this platform. There are a spare set of trestles for a different height, in case the level should require to be altered. At the entrance door a piece of stone runs across the threshold, about two inches above the floor line, to keep any water from flowing out. The concrete bottom of the pit slopes towards a point where a gully is situated. Consequently any water in the pit flows towards this gully and drains off.

The floor of the motor-house itself requires no gully, because it inclines slightly towards the entrance doors, so that when it has to be washed down the water flows to the outside. Of course the pit can be entered from above if desired.

Plans of the motor-houses at Broomhill are here shown to scale, since it will render the description clearer, and show all the arrangements at a glance (see figs. 1 and 2). There is also a picture of the motor-houses taken from a photograph in fig. 3. The fifth house is not seen in this picture.

The motor-house is illuminated by means of electric light, connectors are placed in the walls on either side, and also in the pit, for portable electric lamps which are most necessary for making examinations. One of the best forms of lamp and lamp-holder which have ever been devised is that made by the Edison and Swan Company, and intended for the examination of the interior of barrels. The shape of the lamp and the nature of its protection are such that it can be inserted between all parts of the machinery where a couple of inches of space exists. There are also the safety lamps using benzine supplied by Messrs. Carless and Lees, which can be used



Section on line AB



Section on line CD



Front Elevation

Fig. 1

—The Motor Carriage Houses, Broomhill—

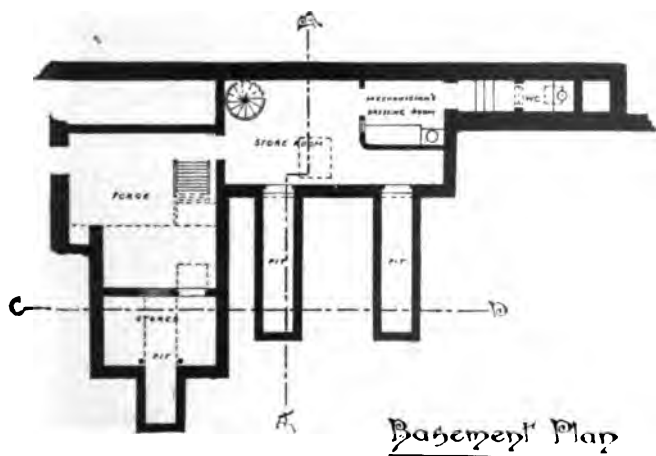
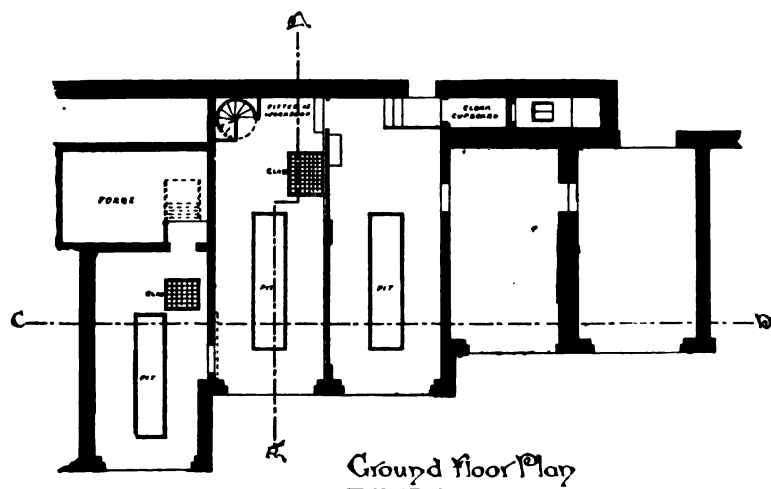


Fig. 2

if an examination has to be made in the absence of the electric light when benzine vapour is likely to be about. In the motor-house there are three tanks which hold about six gallons each with self-contained pumps. Two of these contain oil, one being thick and the other more fluid. The third is a seamless steel barrel which holds benzine. There is also a large metal bottle with a screw top, in which is placed any old benzine that is used for cleaning purposes. The main store of petroleum spirit is at a considerable distance from all



Fig. 3.—The Motor-houses at Broomhill, Tunbridge Wells

buildings. One of the neatest types of self-contained oil reservoir and pump is that made by the Richter Oil Economising Company of Bradford. Many other types are in existence, but none of those with which I am acquainted is so well finished.

The roof of the house is strengthened at certain points by cross timbers which support two small **H** girders, and carry iron frames to which are attached pulley blocks. These little frames can be slid along the girders in the direction of the length of the carriages below. By means of this arrangement

a carriage can be lifted off the ground, or any heavy portion of the machinery raised from the car without difficulty. There is also another use—*viz.* that with a dynamometer the weight of a vehicle can very fairly be estimated by lifting first the fore part and then the hind part just off the ground, and adding the two weights together.

If a pit does not exist, such an arrangement can be made to take its place, by raising the car to a convenient height above the floor.

A zinc tray about four feet long and about six inches narrower than the track of the car should be put under each vehicle to catch the drip, and for placing dirty waste in. In this manner cleanliness is cultivated. Wedges are also required for placing before and behind the wheels of a car when it is desired to keep them immovable.

It is money saved to have duplicate special tools in the motor-car house, since a great deal of wear and tear to the cars is avoided, due to the constant opening and shutting the drawers and cupboards to obtain the tools therefrom. The tool cupboard in the motor-house should also contain a complete set of all the spares which are usually carried in the cars, apart from other duplicate portions which it is usual to keep in stock; or nothing is more annoying than for a driver to find himself miles from home when some little spring or other matter may be required, and is found to be absent because it had already been used and a new one had not been put back in the carriage. In short, it is a good rule for the mechanic to have strict orders never to use a tool or duplicate part in the car except when on the road.

The ventilation of a motor-car house has not so far been referred to, for in reality it is almost unnecessary. The constant opening and shutting of the large doors give ample air, and if the tanks and joints on the car are kept tight, as they should be, no smell of benzine gas will be found at any time present. At the same time it is desirable that ventilation should exist, as it may be necessary to clean the cars with the

doors closed in bad weather. Large brass gratings capable of being closed should be placed in each of the upper portions of the entrance doors, and these will be found sufficient for the purpose.

It is also desirable to warm the motor-house. This is done at Broomhill by means of hot water. In many cases this method may appear difficult to carry out, and it is no uncommon practice to leave a gas-burner alight to keep out frost or to warm the room for the attendant when the weather is cold. Such a proceeding is clearly not desirable when there is a risk at any time of the presence of an explosive gas. Very simple heating arrangements by means of hot water can be purchased, some using gas and others burning petroleum as the source of heat. The little boiler in this case would be placed outside the motor-car house in a small brick shelter, and the pipe carried through the wall to the coil or coils in the usual manner. For a motor-house such as that which has been described, the apparatus would not cost more than from 5*l.* to 10*l.*, according to the character of the one selected.

In every motor-car house there should be two or three tinned-iron open boxes, of the nature of waste-paper baskets, about one foot square and two feet high. One of these should be kept filled with dry sand, and contain a small shovel. This is useful in case any benzine should catch fire, to smother the flames. The others are required to throw any waste substances into. Also on the wall there should hang two or three pails, kept full of water, to be ready in case of fire. It must always be borne in mind that water must not be poured on burning benzine, since the spirit would float upon the water, and in a burning state flow all over the place, thus increasing the danger.

There are also important points to be attended to inside the motor-house apart from the building. Always buy the best waste. It costs but little more than the bad quality, and lasts double the time, while it is generally free from dust and grit, and if great saving is desired, it can be boiled down



A MOTOR HOUSE IN LONDON

with soap and soda for use again. A common quality of woolly waste should also be employed, simply for mopping up oil, not for cleaning purposes. It is undesirable to store a large quantity of oily waste for fear of spontaneous combustion. Sponge cloths are a desirable accessory for cleaning and for polishing up. The panels of the carriage should be cleaned with good chamois leather. Inferior qualities will scratch the varnish. The various brushes, &c. required for cleaning are much the same as with a horse-drawn carriage. A great economy is effected by having a separate receptacle for old dirty oil, to be used only for cleaning purposes. Care must be taken that oil does not fall on any part of the pneumatic or solid rubber tyres, as it soon destroys the rubber. Boiled linseed oil is an excellent material for getting up the varnish, and petroleum sold under the name of kerosene will work wonders on varnish work and enamelled metal when all other means fail.

To keep a carriage in good order continual touching up is essential, not only where little chips of paint have been broken off, but also on the engine to give it a respectable appearance. No better material exists in the way of general paints than the Griffiths' enamels, which dry almost immediately, and are acid and heat proof and very hard. The black enamel is well suited for the over-heated portions of the engine, since it keeps its colour, unless the metal is brought to a red heat. Many kinds of aluminium paint have been tried for engines, and the majority have been found wanting. The paint which meets with perfect success in all respects is that made by Messrs. Ripolin of Paris. It is expensive, but the material goes a long way. The paint is used extensively abroad for the purpose indicated, and for decoration. With aluminium paint it is always desirable to give a final coat of Griffiths' transparent varnish. This will enable the owner to wash his engine at any time without in any way altering its appearance from that of being brand-new.

It is fatal to fold up the air-tubes and covers of the

pneumatics for any length of time, or to allow them to be exposed to too great cold or heat. Therefore the air-tubes and envelopes should be hung on the brackets on the wall, and the air-tubes should be kept inflated to a small tension. Since, as has been stated, no direct sunlight reaches the house, danger from excessive heat is avoided. Besides, the heat of the sun might burst the air-tubes on the vehicles standing in the house, or even prove a source of danger to the benzine reservoir by heating the liquid.

Money is not wasted if the owner of the car purchases five jacks for every carriage, one to carry on the car itself, and four to be used in lifting the wheels off the floor, no matter whether the tyres are furnished with pneumatics or solid rubber. Of course, this proceeding would not be resorted to except when the carriage is left for some considerable time without being used, and this practice will greatly prolong the life of the tyres.

All tyres should be repaired at once, and not left for chance moments.

It is usual to wash the horse-drawn carriage directly on reaching the stable, because the mud can be more easily removed when wet, and without the risk of scratching the varnish. This process, however, cannot always be resorted to in the case of a motor-car, on account of the machinery being hot. It is therefore desirable to wet the mud well before removing it. A large Turkey sponge is best for cleaning the body and wheels of the car, and after washing, everything must be dried with sponge-cloths or leathers, according to the nature of the parts to be wiped. The engine itself, and any other working parts, are better cleaned with damp sponge-cloths and finally wiped over with oily waste. The bright parts are cleaned with selvyt, leather, or other suitable material. In no event must water be dashed over a car after the manner of cleaning ordinary carriages, although a hose is convenient for washing, since the water can be carefully directed to the required points.

It is almost the universal practice abroad to wet the clutch

and brakes. At times the leather on the clutch (when it exists, as it generally does) becomes very polished, and is apt to slip. Sometimes dust or grit gains an entrance, and prevents it from gripping. Water cleans, expands, and roughens the leather without injuring it. Some owners clean their clutch with benzine. This practice is, however, objectionable, because the volatile portion of the benzine evaporates, and invariably leaves behind traces of oily matter, since perfectly rectified benzine would be too expensive to use, and would probably mean that a shilling would be spent each time the clutch was cleaned. It will be seen, therefore, that it is only a question of time when the clutch will become lubricated. However, if oil should by chance get into the clutch or on the brakes, this must be removed with ordinary benzine; but the occurrence should be rare if proper care is taken. By these remarks it must not be supposed that the clutch and brakes should be wetted daily. Once a month, or less often, is sufficient, even when a car is used constantly. On the road also, if a clutch does not act, due to slip, a small dose of water puts matters right at once if the mechanical portions are in order. It is necessary to point out that neither water nor moisture should come in contact with any of the electrical portions when they exist, i.e. primary battery accumulator, and magneto should be kept perfectly dry, also all conductors, insulators, and other electrical apparatus. The moisture itself, if the water is pure, will have practically no effect on the working of the apparatus, because this liquid is a very good non-conductor. Danger enters by the adhesion of dirt, due to the moisture, which causes the current to leak.

Every car should have mackintosh rain-covers, neatly made, so as not to be disfiguring, for use in wet weather; also dust-covers, which are useful on many occasions. In damp weather the carriage should be left entirely uncovered when standing in its house, since the covers become moist, and the carriage is enveloped in a wet cloth, when in a short time it will be found that all the leather parts have become mildewed. A

thermometer must be placed in the motor-house, for observing the temperature. In the one described it will be noticed that the mercury will not fall, in the coldest winter, below fifty degrees Fahr. or rise, in the hottest summer, above seventy degrees Fahr.

It is of vital importance that frost should be kept away from the motor-car, in order that the circulating water shall not freeze, and possibly burst some part of the apparatus. To empty the water daily in winter-time is a vexatious proceeding, because when it is replaced there is often the difficulty of restoring the circulation owing to air becoming lodged in the pipes or elsewhere. Quite apart from this consideration it is desirable to keep the same water as long as possible in the circulation apparatus, thus to reduce deposit in the tubes and not disturb any rust that may exist. If the water is removed daily, various pipes and other portions made of iron, 'thin out,' on account of affecting so frequently the thin layer of rust which forms. When the apparatus is in use the circulation is not sufficiently violent to detach the oxide, and the thin coat preserves the iron below, being insoluble in water.

Thus it will be seen that the small expenditure on a hot-water system and the cost of running it is money saved in the end, and many a breakdown owing to bad circulation will be avoided. It may be desirable for the benefit of those who do not know where such small heating apparatus may be obtained, to give the names of two or three firms who supply the requirements, viz., Messrs. Keith of Farringdon Avenue, E.C., Messrs. Crompton and Fawkes of Chelmsford, and Messrs. Fletcher of Warrington.

It is very difficult to draw a line between stable management and motor management. Probably apart from the cleaning of the car; oiling the bearings and grinding the valves come within the province of the stable attendant. The oiling arrangements are so straightforward that there is little need to give special instructions under this head. It is, how-

ever, important to count the exact number of oil holes and grease cups existing in any car, and to have this painted in the car somewhere out of sight, giving instructions to the attendant to count up as he oils round. In this way no place will be forgotten.

When any difficulty occurs with a car many drivers at once accuse the electric ignition, when it exists, and next the valves, for the default. The unfortunate valve comes in for a great deal more abuse than it deserves. The less grinding they are given the better. When the operation is necessary of course it must be done. If the car is used daily, for say eight hours, and the oiling of the cylinders has been properly adjusted and not too profuse, it will be sufficient if the valves are removed weekly, to be wiped over with an oily rag, and then cleaned with a little heavy petroleum or benzine. If it should be observed that the bearing surfaces are pitted, then grinding should be resorted to, but this will not often be the case with experienced owners.

It is a very simple matter to grind the valve by adopting the following process. To give an example, we will consider the case of one valve, since it will apply equally to the others. The valve itself must be rendered free by the removal of all springs, and a little emery of the finest description, almost like flour, should be mixed up into a paste with oil. The bearing surface of the valve must then be coated with a thin layer of this paste by means of the finger, and placed upon its seating. It will be observed that there is a slot in the valve ready to receive the screw-driver. This tool is now employed in twisting the valve right and left, at the same time pressing it down on its seat with moderate force, turning always to an angle of say forty-five degrees to and fro. Then turn the valve a little round, and continue the operation, the object being not always to grind in the same place. When this operation has been continued for the space of a minute, the valve should be removed, and the rubbing surface on the valve itself, as well as its seating, be examined to see whether the

rubbing is equal at every point round, and that the pit marks are now absent. Should this be the case, the operation is concluded. If not, it must be continued, using a little more of the emery paste until the desired result is obtained. Every trace of emery must then be removed by means of rags or waste wetted with petroleum or oil, and on no account should any remain, for the reason that it might enter the cylinder, bearings, or some other part of the machinery, and set up a friction which is hard to remove, since emery particles will embed themselves in the hardest steel. The emery rags and other things which may be employed for grinding valves should be kept apart, to run no risk of emery dust entering any rubbing parts of the motor.

It is desirable that all benzine which is placed in the car, and all oil which is used, should be entered in a book, say once a week, in order to prevent extravagance and waste, and all storage tanks should have a gauge-glass marked in gallons or litres, in order that their contents may be observed. These gauge-glasses must of course have taps, or the breakage of a tube would empty the contents. The owner should once a month, or at any other suitable times, see by the book how much has been removed from the tanks, and by comparing this with what remains he will be able to judge how matters go.

It is desirable that any repairs, small or great, should be attended to at once. This is the only way to keep a car ready at all times for use. Every car on being delivered possesses certain faults which the owner should remedy. It is true that the faults are details, and consist of omissions by the makers on account of expense, in consequence of trade competition, which would make their car appear more expensive than that of some rival. The public as a rule would not appreciate the little advantages for the extra expense incurred, though the want of them is felt later on. It is impossible to detail the whole of the points, since every make of car varies to some extent, but the lines upon which the owner should proceed may be indicated.

Every portion of the machinery should be arranged, as far as can be done, in such a manner that removal can be effected upon the road without use of tools, or with the least number. To give a few examples :—If burners exist, in order that the platinum tubes may be replaced without extinguishing the burners, additional taps of more perfect make should be provided in lieu of many of those which do not cut off with certainty, due to their construction. Extra taps in the course of the benzine tubes should be added, so that the fluid may be cut off at more than one point in case of fire. The nuts should be changed as far as possible to certain gauges to diminish the number of keys required. The locks of drawers and cupboards throughout should be passed with one key. Every nut on the car should have a spring washer placed under it, and the end of all bolts and studs pinned where possible. All break rods and clutch rods should be cut and joined together by means of a right- and left-handed screw coupler, with lock nuts on the rods, in order that adjustment may be made on the road with despatch, and the best tensions for these rods be obtained without trouble. All these details and many others which suggest themselves, according to the type of car, should be attended to, and they will repay the owner in a very short time.

The careful storage of benzine is a very important matter. No licence is requisite for the benzine carried on the car, which must not exceed forty gallons. If all reasonable precautions are followed, there will be no difficulty in obtaining a licence for the general storage. The benzine-store at Broomhill is constructed in the following manner : It is a lean-to house eight feet long, three feet wide, seven feet high in front, and nine feet at the back. All the walls are of nine-inch brickwork, and the bricks in the side walls are so laid that the ends of them do not meet, in order to allow a free current of air to pass through. The fourth side is filled in by a pair of doors lined with iron. The roof consists of corrugated iron laid on T iron. The floor has a bed of concrete six inches

thick. The sill is of such a height that if the tank or tanks were to leak, and let out the whole of the liquid, it would still be retained within the house. In order that this sill should not be inconveniently high the floor is sunk. In the case referred to the sill is about six inches high, and this floor tank, so to speak, is almost filled with sand to act as an absorbent. There are two closed tanks, each of which holds 300 gallons. The inlets and outlets of each tank are arranged thus: a pipe issues from the bottom of the tank with a stopcock, and is



Fig. 4.—Benzine House

only used for emptying the tank completely and removing the dregs. Another tap is placed six inches from the bottom, and is the one used to draw from. Another pipe with a stopcock is inserted three inches from the bottom and at the side, to carry the gauge-tube. The gauge-glass has a scale by the side of it marked off in gallons and litres. Close to the top of the tank is a large hole with screwed plug. Into this is screwed a pipe which carries a suitable funnel for filling. There is also a small tap inserted at a suitable height, attached to

which is a pipe which passes through the tank and upwards to the top, where it is open, and is used as an air outlet when filling the tank. All the fittings are situated on the front side, and when the doors are shut they come close to them so that the person who attends to the tanks stands outside. The tanks are painted in large letters with the words, 'Highly Inflammable.' The building is situated a very considerable distance from other structures, and kept locked. An illustration of the benzine-house is shown in fig. 4.



Fig. 5.—The Hon. Evelyn Ellis's Motor-house at Datchet

The owner of a car must always remember that the best master of the mechanism is himself, and he should therefore take care to conquer all its intricacies and difficulties. Any time and patience that he spends in this manner greatly increase his power, and they are not wasted on any particular car, since nine points out of ten are common to all types of motor-carriages which are worked upon a similar system.

There is no need to deal with steam and electrically driven cars specially under the head of 'Stable Management,' because

all the above remarks apply, excepting those which have special reference to cars carrying motors of the gas-engine type.

Fig. 5 represents the stabling of the well-known motor-car owner, Mr. Evelyn Ellis. He places his pit outside. When this is done a wooden or metal rail must run along each side of the pit as seen in the picture, to prevent a car from being rolled in ; when the pit is in the motor-car house this precaution is unnecessary. The full-page illustration opposite shows Mr. Alfred Harmsworth's motor stables.

CHAPTER VII

THE PETROL ENGINE

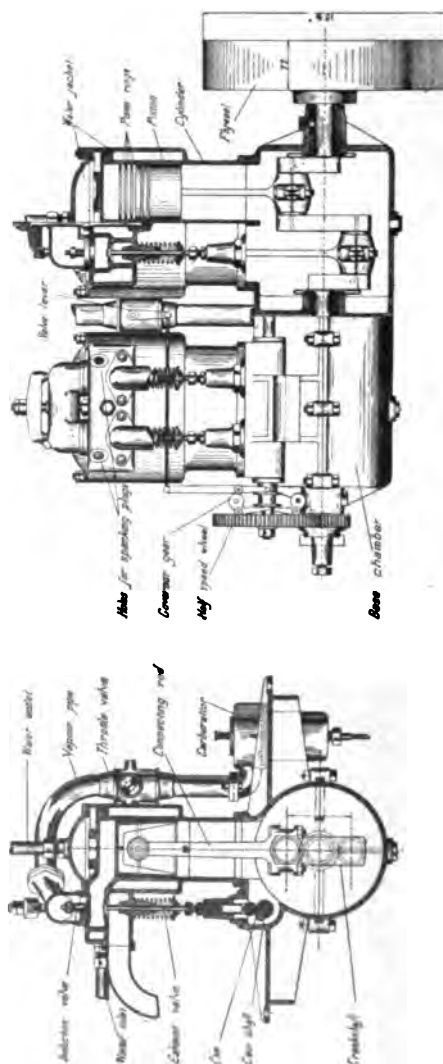
BY R. J. MECREDY, EDITOR OF THE 'MOTOR NEWS'

EVERY motor-car owner, whether he can afford to keep a mechanic or not, should make a point of studying and thoroughly understanding his engine. It is not merely that this will save him trouble and emancipate him from the tyranny of the skilled mechanic, but it will very materially increase his pleasure in the pastime, for the study of the engine affords almost as keen enjoyment as the actual driving.

The man who is uninitiated is likely to regard with despair the prospect of ever being able to understand the apparently complex machinery which propels his car. In reality it is exceedingly simple. Very little study will enable him thoroughly to grasp its principles, and after that the rest is merely a matter of common sense. When he has once learned how the engine works, and wherein it is likely to fail, he will quickly diagnose troubles which would otherwise prove insurmountable.

Of course, if one can afford it, it is desirable to keep a skilled mechanic, but it is an enormous advantage to feel that one is independent of his services, and cannot be 'taken in,' as is the ignorant novice. A mechanic, however, is by no means necessary—an ordinary handy man can quickly be taught to clean and lubricate, to keep the working parts thoroughly adjusted, and even to diagnose the ordinary roadside troubles which are bound to occur.

From this it will be seen that it is almost essential for every motorist to know something of his car; and the purpose of this



Sections of Daimler Co.'s 4-cylindrical Motor

chapter is to give the novice a complete insight into the various parts of a petrol engine, and their respective functions.

What is a Petrol Engine?—‘Petrol Engine’ is a slang term for an engine driven by a series of explosions of a mixture of the vapour of a light spirit of petroleum with air.

‘Gas engines’ are similarly driven by explosions of a mixture of coal gas and air.

Both are known as ‘internal combustion engines.’

In order to explain the system, there is here taken as an example a single-cylindered engine of the Daimler type.

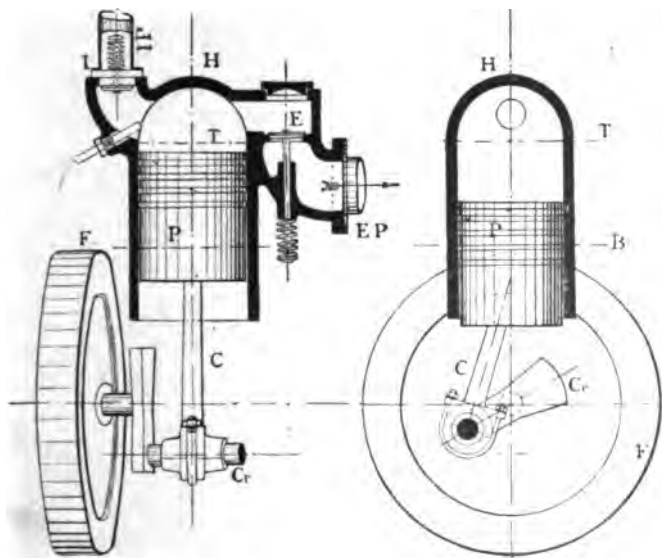


Fig. 1

Fig. 2

Fig. 1 represents a drawing of such a motor if it be cut in half; fig. 2 the same motor cut in half the other way through.

P is a piston which accurately fits in a cylinder, and is free to pass up and down the interior of same. The top of the piston travels between the dotted lines at the top, T, and the dotted line

at the bottom, *B*. The piston *P* is connected by the connecting rod *c* to the crank *cr* by means of which it turns the fly-wheel *F*.

Compared with the propulsion of the front wheel of the old high-wheeled bicycle, the connecting-rod (*c*) represents the rider's leg, the crank (*cr*) the crank of the bicycle, and the fly-wheel (*F*) the large wheel of the bicycle.

The force which drives the piston downward, and so operates the fly-wheel *F*, is generated by the explosion of a mixture of gas and air in the combustion chamber *τ*. This mixture reaches the combustion chamber through the induction pipe *IP*, and the induction or inlet valve *I*. It is fired by an electric spark occurring in the combustion chamber, or a red-hot platinum tube protruding into same, and the exploded charge is ejected through the exhaust valve *E*, as will be hereafter explained.

THE SUCTION STROKE

Let it be supposed that the fly-wheel has been set rapidly revolving, that the piston has been up at the top at *τ*, and has just descended to the bottom of its stroke (*B*). In doing this it sucks down the valve *I* (called the inlet or induction valve), which is otherwise held closed by a spring, and thus draws through the valve from the induction pipe (*IP*) a mixture of vapour of petrol and air.

When the piston is at the bottom (*B*) the cylinder is fully charged with this explosive mixture.

The suction having stopped, the inlet valve is closed by its spring, and the cylinder is then air- or rather gas-tight.

THE COMPRESSION STROKE

The momentum of the fly-wheel then thrusts the piston up to the top (*τ*) again, and in doing so, as there is no escape, the explosive mixture which had previously filled all the space in the cylinder between its head (*H*) and *B* is compressed into the very small space remaining between *H* and *τ*.

This is what is known as compression. The explosive mixture has to be thus compressed before it is fired.

THE EXPLOSIVE STROKE

At this point the explosive mixture is fired either by means of an electric spark or by a heated tube. The systems of firing are dealt with in the chapter on Ignition (Chapter VIII.).

It is sufficient at present to note that the highly compressed explosive mixture is fired, and as there is no outlet for the suddenly expanded gases (for the force of the explosion only tends to close tighter the inlet valve *I* and the outlet or exhaust valve *E*, which are referred to later), the whole force of the explosion goes to thrust down the piston from *T* to *B*. It is this thrust which gives the fly-wheel its momentum, its swing ; it is this thrust, in fact, which makes the car move.

THE EXHAUST STROKE

At this point, when the piston is down at the bottom, at *B*, another valve, the exhaust valve (*E*) is opened (by an arrangement which is explained hereafter), and is kept open during the whole of this up-stroke from *B* to *T*, the consequence being that the exploded mixture is thrust out through this exhaust valve, which closes immediately the piston gets to the top again (*T*).

A COMPLETE CYCLE

This is the whole operation :—

Fig. 3, Diagram A.—A spot is shown upon the fly-wheel before the beginning of the operation.

Fig. 3, Diagram B, shows that during the suction stroke the fly-wheel has made half a revolution.

Fig. 3, Diagram C, shows that during the compression stroke a further half-revolution is made and the spot has returned to its starting-point.

Fig. 3, Diagram D, shows that during the explosive stroke a further half-revolution of the fly-wheel is made.

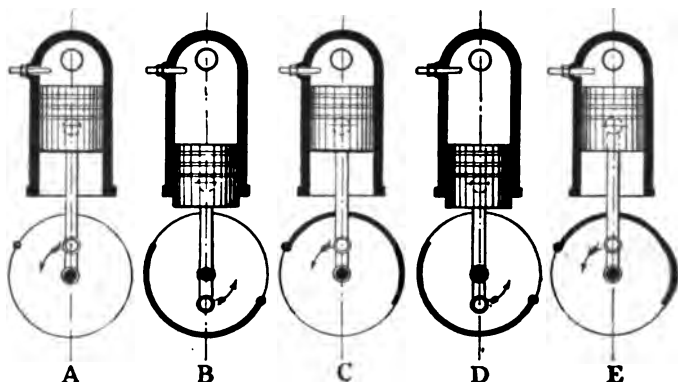


Fig. 3.—A complete Cycle

Fig. 3, Diagram E, shows that during the exhaust stroke a fourth half-revolution is made. So for every explosion there are two complete revolutions of the fly-wheel.

INDUCTION VALVES

In Fig. 1 it will be seen that the interior of the cylinder is separated from the induction pipe 1 P by an inlet valve marked 1.

Fig. 4 (a) shows the induction valve in its place in the wall of the cylinder, and closed so that no mixture can pass.

Fig. 4 (b) shows a section of the induction valve when the valve is open leaving a free passage for the mixture in the direction of the arrows.

The spring above the valve is of such a strength that it keeps the valve closed, except when the power of suction is exerted, when it opens and the explosive mixture is admitted from the induction pipe through the aperture thus made.

EXHAUST VALVE

In Fig. 1 it will be noted that the exploded gases are expelled by the rising piston from the cylinder through the exhaust valve *E* and exhaust pipe *E P*.

Fig. 5 (a) shows the exhaust valve in its position in the wall of the cylinder and closed against the escape of the exhaust gases.

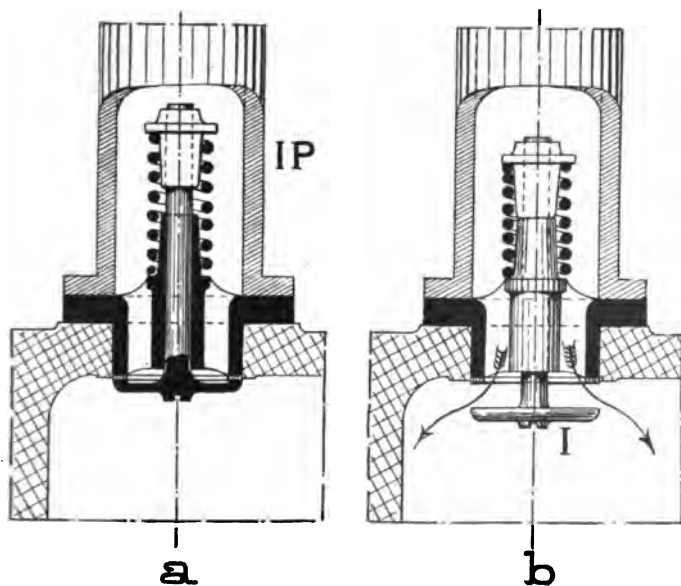


Fig. 4.—Induction Valve

Fig. 5 (b) shows a section of the valve when it is open, leaving a free escape for the exhaust gases in the direction of the arrow.

It will be noted that the valve is kept in its seat by means of a spring, and it remains in this position throughout the suction, compression and explosion strokes. During the exhaust stroke, however, when the explosive gases are expelled from

the cylinder through the exhaust valve into the exhaust pipe, the exhaust valve is held open by a mechanical contrivance.

THE MECHANICAL LIFT OF THE EXHAUST VALVE

The simplest form of exhaust-valve mechanism is to be found in engines of the De Dion type, as illustrated in fig. 6.

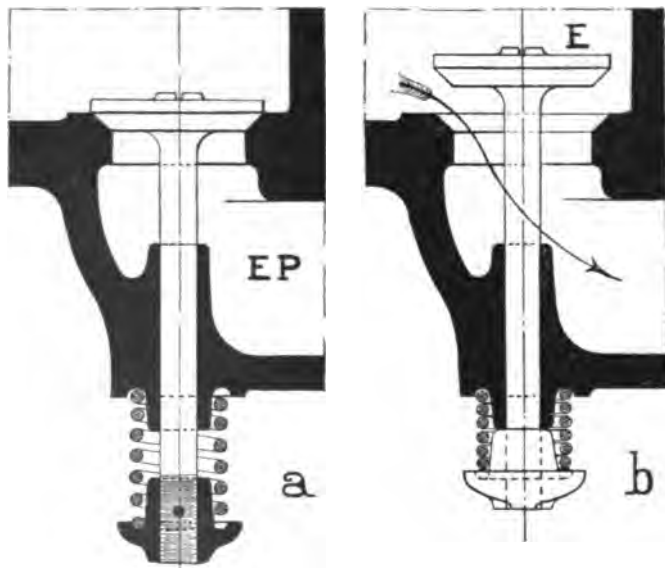


Fig. 5.—Exhaust Valve

A is the end of the crank-shaft (fly-wheel shaft) on to which the small gear wheel B is fixed. This wheel engages with another wheel C, which revolves on the shaft D. The gear wheel C is double the size of B, consequently C only revolves once for every two revolutions of the crank shaft. In the solid with wheel C is mounted an eccentric cam E, which raises the exhaust valve H against the pressure of the spiral spring G, thus allowing the exploded gases to escape from the cylinder. The mode of working

is very simple. When the cam *E* revolves so that the projecting part comes on top, it pushes up the plunger *J*. *J* in turn pushes the spindle *F*, which carries on its top the exhaust valve *H*, and the latter is consequently removed off its seating and permits the exhaust gases to escape. As *E* continues to revolve the protruding portion sinks from under *J*, and the spring *G* pushes the exhaust valve *H* to its position on its seating. Needless to say, the gear wheels *B* and *C* must be so set that the cam *E* will open the exhaust valve *H* at exactly the right moment.

The action of the exhaust valves in the two cylinder engines of the Daimler type is described further on under the heading Governors. The principle is exactly the same.

CARBURETTER

The mixture, the ignition of which causes the impulse which drives the engine, is formed from the vapour which rises from petrol or motor-car spirit when mixed in proper proportions with air—in other words, when this air is carburetted. The chamber in which this mixing takes place is consequently called the carburetter. There are three types of carburetter, which we will now describe.

(1) *The Surface Carburetter*, as used on the De Dion Motor Cycle.—This carburetter is so designed as to give a considerable surface of spirit, off which the vapour rises, and together with a certain quantity of air is sucked into the mixing chamber, which is commonly known as the twin tap. In this mixing chamber the proper proportions of air and gas are finally regulated so as to give a perfect mixture. Fig. 7 explains the construction of the carburetter.

H is a pipe taken off the exhaust which carries a portion of



Fig. 6.—Exhaust Valve Lifter

the exploded charge through, but not into the petrol, for the purpose of warming it, and so assisting in its better vaporisation.

J is the air inlet, and attached to its lower extremity is a plate L. The suction of the piston through the induction valve and supply pipe causes a rush of air down through J, which mixes with the vapour rising from the petrol, and is drawn upwards into the twin tap, or mixing chamber on the top of the carburetter. The plate L is to prevent the petrol

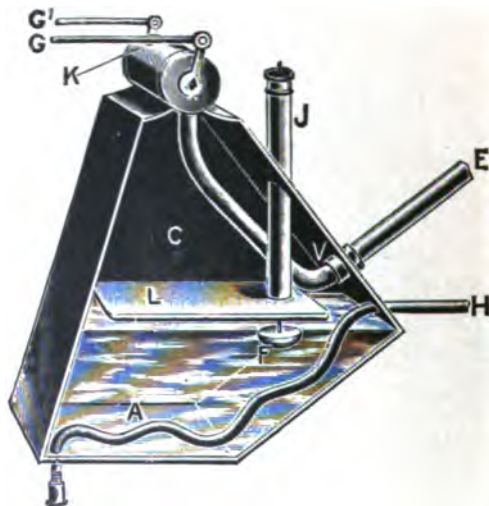


Fig. 7.—The De Dion Carburetter

from splashing upwards, and to diffuse the air over the spirit, and its position can be regulated by raising or lowering the tube J, so that it will rest just above the surface of the petrol. As will be seen, the plate L does not touch the sides of the carburetter, and consequently the vapour forming by the mixture of gas and air can rise round its sides into the upper portion of carburetter C, in which the mixing process is continued. F is a float with wire attached to indicate the height of the petrol.

K is the twin tap in which the mixing is finally completed.

G' is the lever regulating the amount of air admitted to the twin tap, and by means of which the quality of the mixture is controlled. It is generally called the 'quality lever,' as it determines the quality of the mixture.

G is the lever regulating the aperture in the bottom of the twin tap, by means of which the perfect mixture is admitted to

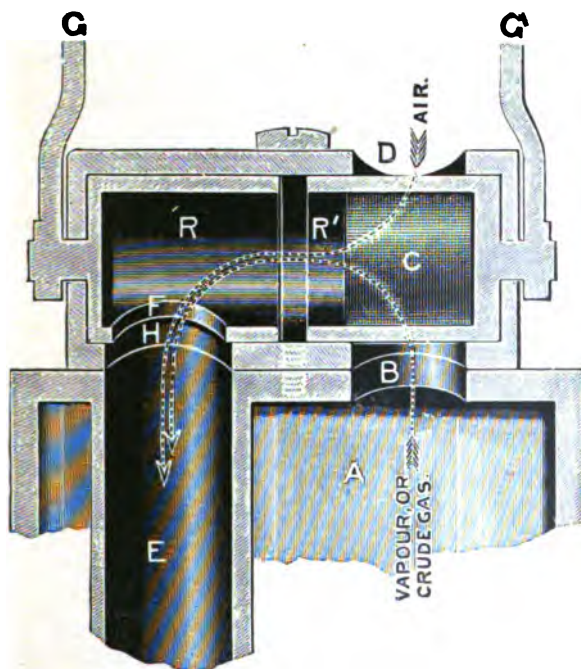


Fig. 8.—The Twin Tap or Mixing Chamber

the combustion chamber of the engine through the pipe E —in other words, it is a throttle lever. It is generally known as the 'quantity lever,' as it regulates the quantity of mixture reaching the combustion chamber, and consequently the force of the explosion.

v is a safety chamber of wire gauze to prevent the flame from the combustion chamber reaching the carburetter.

The construction of the twin tap will be seen from fig. 8. It consists of two concentric cylinders; the outer cylinder is in one piece, but the inner one is separated into two short cylinders, κ and κ' , which are manipulated inside the outer one by the levers G and G' .

A is the upper part of the carburetter, corresponding to c in fig. 7. B is the aperture through which the crude vapour ascends into the twin tap, passing through the wire gauze *C en route*. D is an aperture on top of the twin tap, through which the ordinary air enters. By the suction of the engine this crude vapour and air are drawn into κ' , and, mixing as they go, enter κ , and so into the pipe E, and thence are drawn into the combustion chamber of the engine. As already mentioned, the lever G' operates the cylinder κ' , through which circular holes are cut, to admit the crude vapour and air. When the lever is in a certain position nothing but crude vapour is admitted to κ' . By operating it, however, the air inlet D is gradually opened, and at the same time the vapour inlet B is gradually shut, thus regulating the quality of the mixture, or in other words the relative proportions of air and crude vapour. Similarly the lever G , operating the cylinder κ , either opens or closes the aperture F, thus regulating the quantity of mixture which passes from the mixing chamber to the combustion chamber.

Elsewhere in this volume the importance of having the mixture correct both in quality and quantity will be duly dealt with.

The sectional view of that portion of the tap which governs the quality of the mixture, shown in figs. 9 and 10, will perhaps more clearly explain the way it works. In fig. 9 it will be seen that the crude gas aperture B is almost wholly closed, while the air aperture D is almost fully open. In fig. 10 B is half open and D half shut. It can be seen how the tap can be operated so that B will be wholly closed and D wholly open, or *vice*

versa. c is the gauze through which the crude gas and air pass.

(2) *The Benz Carburettor.*—The second type combines features of the first and third, inasmuch as the principle of carburation is the same as the first, i.e. surface type, and the method of supplying petrol to the carburettor is on the same principle as the third, float feed. The chief examples of this type are to be found in the 'Benz' cars. The apparatus consists of a cylindrical vessel having a small compartment in the bottom through which a portion of the exhaust gases passes. The heat so derived assists in vaporising the petrol. A tube reaching to a point just above the level of the spirit admits the

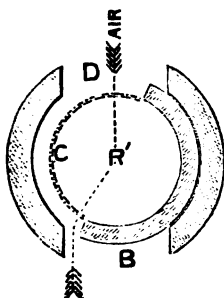


Fig. 9

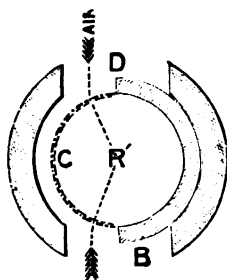


Fig. 10

necessary air, which may be regulated by a cap covering the holes through which the air is drawn. Another pipe projecting into the vessel conveys the carburetted air to the combustion chamber of the cylinder, into which it is drawn by the suction of the piston. The petrol supply pipe enters the side of the carburettor, and is bent downwards. On to the inside of the carburettor a lever is hinged, carrying a cap which closes the inlet pipe, when the opposite end of the lever is raised by a float contained within the carburettor. When the level of the petrol sinks, the float sinks with it, releasing the pressure from the end of the lever, and so admitting a fresh supply of petrol.

(3) *The Spray Carburetter.*—The carburetter fitted to the Daimler two-cylinder engine is a good representative of this class. It is depicted in fig. 11. The general principle is as follows: The petrol enters the float chamber E through a pipe G. It is then drawn by the suction of the engine along a circular passage, and through the jet H, and impinges against the sloping sides of the carburetter. At the same time air is drawn though the air cylinder D and into the jet chamber through

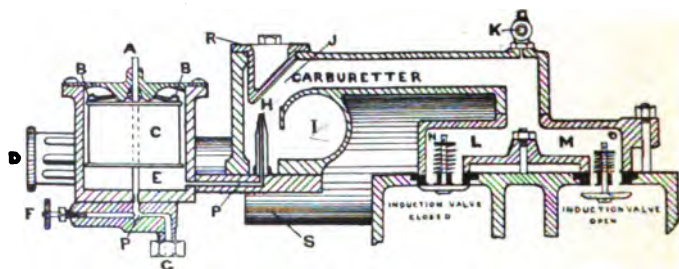


Fig. 11.—The Daimler Carburetter

A, float spindle with valve admitting petrol to float chamber at end; B B, arms actuating the valve A through the float C; C, float actuated by rise and fall of the petrol in the chamber E; D, air inlet to carburetter; E, float-feed chamber; F, valve which cuts off supply of petrol to the chamber E; G, petrol inlet; H, jet through which the petrol sprays; I, orifice through which the air is drawn from D into the carburetter; J, carburetter; K, tap to admit further supply of air; L and M, passages through which the mixture passes on its way to the induction valves; N, induction valve, shown shut; O, induction valve open; P P, passages through which the petrol passes; R, removable piece against which the spray is ejected; S, chamber through which the air, entering at D, passes on its way to the carburetter.

the aperture I. Here, rushing upward, it mixes with the atomised petrol, and the two are thoroughly mingled in the carburetter, and are thence drawn along the passages L and M to the induction valves, which in turn give admission to the combustion chamber.

The supply of petrol is governed as follows: As it ascends through pipe G into the float chamber E it raises the float C until the petrol has reached a point in the float chamber almost as high as the top of the jet. At this stage the upward move-

ment of the float *c* actuates two arms *B*, *b*, which are attached to the float spindle *A*, and which depresses this float spindle until the conical end of it blocks up the aperture through which the petrol ascends. No more petrol can thus reach the float chamber until, by the depression of the float, this valve spindle is allowed to rise. By this means the petrol is always kept at a constant level in the float chamber. At *κ* there is a tap fitted by means of which a further supply of air can be admitted to the carburetter to suit the condition of the atmosphere or the varying demands of tube or electric ignition. By screwing *F* home into the socket *P* the supply of petrol is wholly stopped.

There are many varieties of the spray carburetter, such, for example, as the well-known Longuemare and the carburetter used on the De Dion car (as distinguished from the De Dion cycle), but in all the general principle is the same. In most of them a hand-worked lever regulates the quality of the mixture.

Two systems of feeding the spray carburetter are used, known respectively as pressure and gravity. In the case of the first named, the petrol tank is situated in the body of the frame at a lower level than the carburetter. Air is pumped into this tank, the pressure afterwards being kept up by the exhaust gases. The pressure of this air on the surface of the petrol forces it upward through a pipe into the carburetter, and where tube ignition is used, into the burners.

With the gravity-fed carburetter the tank is fitted in the body of the car, either under the front seat, between the front and back seats, or under the bonnet at a higher level than the carburetter, and the petrol finds its way into the carburetter by force of gravity.

Both systems have their adherents, but gravity is rapidly ousting pressure. The former certainly can be claimed to be the most simple and effective, but the latter is perhaps the safest, because any leakage of petrol can immediately be stopped by turning off the pressure cock.

SILENCER

The exhaust pipe from the engine which conducts off the exhaust gases after they have done their work in the cylinder is connected to a peculiarly constructed chamber, called a Silencer, attached to the frame of the car. The object of the silencer is to deaden the noise of the escaping gases by :—

1. Breaking up the body of gas into a number of fine streams.
2. Allowing the gases to expand and cool.
3. Checking the velocity without putting back pressure on the engine.
4. Reducing the pressure of the gases till they are as nearly as possible the same as the atmosphere.

To do this, the chamber is divided up into a series of compartments, and the gases in their passage from one to the other have to pass through baffle plates drilled with a number of fine holes, the combined area of which must be considerably in excess of the area of the exhaust pipe, to allow of a free passage for the expanding gases. The flow is thus broken up and subdivided into a number of fine streams of cool gas at or near atmospheric pressure, which cause little or no noise on their escape into the air. It is the sudden expansion of the gases at a high pressure which causes the noise.

Figs. 12 and 13 depict two types of silencer which are very largely used. Fig. 12 shows a sectional view of a silencer composed of three concentric cylinders, A, B, and C. A is composed of a tube or inverted cylinder of sheet steel; B is the second tube similarly constructed; while C is an extension of the exhaust pipe from the engine. Two chambers, D and E, are thus formed. The exhaust gases from the engine enter C, and passing through a number of holes at the end of the pipe at F, expand in the chamber D. Passing from the chamber D through the holes at G, the gases enter the chamber E, where a further expansion takes place. Finally the exhaust is ejected

to the atmosphere through the holes at H. The construction of the silencer can easily be followed from the illustration.

Fig. 13 depicts the second type of silencer, which almost explains itself. 1 is a cylindrical steel body fixed to the end

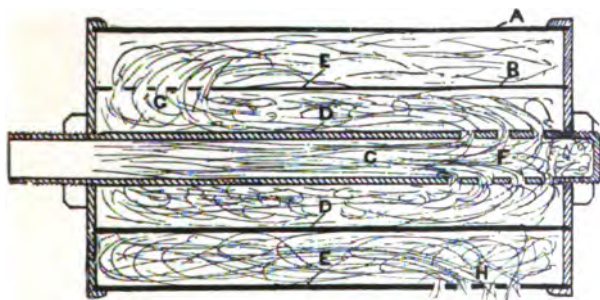


Fig. 12.—Silencer

plates G and H. This body contains the baffle plates A, B, C, D, E, and F. The exhaust gases are seen entering the silencer through the exhaust pipe. The direction which they take through the baffle plates is shown by the arrows, and it

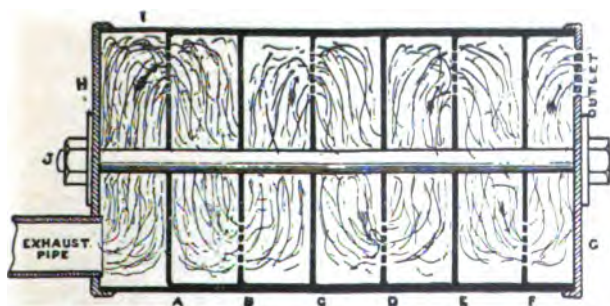


Fig. 13.—Silencer

will be seen that the pressure is reduced in each succeeding compartment in the cylinder. The bolt J, passing through the centre, serves to hold the silencer together and to resist the pressure of the gases.

SYSTEMS OF GOVERNING

To secure the greatest efficiency, durability, and power of the engine, it is necessary, as can be easily understood, to be able to control the speed—in other words, to regulate the number of revolutions of the fly-wheel per minute—and there are various devices for accomplishing this object. The range of speed of different engines varies very considerably. With the small single-cylinder engines it is necessary that the speed should be very great in order to secure sufficient power, and also to reduce vibration, while with the two- and four-cylinder engines this is not necessary, and consequently they are much more durable. As a rule the speed varies from about 750 revolutions per minute for the latter class to 2,000 for the small engines fitted to motor-cycles.

There are various successful methods of governing, which we shall now proceed to enumerate and describe.

- (1) Timing of ignition.
- (2) Exhaust-valve lifter.
- (3) Exhaust-valve closer.
- (4) Regulating lift of induction valve.
- (5) Mechanically governing exhaust valves.
- (6) Throttle.
- (7) Governing both exhaust and throttle.
- (8) Governing by variable induction and throttle valve.

(1) *By Advancing or Retarding the Sparking.*—This is the method adopted for single-cylinder engines, and consists in altering the time at which the spark occurs in the combustion chamber by the manipulation of a small lever. It will be easily understood that if the full force of the explosion occurs in the combustion chamber at the moment when the piston is at the highest point, that its effect will be greatest. This is due to the fact that the compression is then at its maximum, and the force of the expanding gas has a longer time to act on the piston. The compression and duration of pressure on the piston can be reduced by altering the timing of the spark, so that it occurs

after the piston has begun to descend. This system is the simplest, but its effective use depends very largely on the skill and experience of the driver. Where this system is adopted, a throttle is also used, which enables the operator to regulate the quantity of mixture, and thus alter the power of the explosion. For example, when the maximum power is required, the throttle is open to the fullest, and the sparking advanced to the utmost that the engine will take.

(2) *Exhaust-Valve Lifter*.—This operates by preventing the exhaust valve from closing after the exhaust gases have escaped. When the exhaust valve is held fully up, no explosive charge is taken into the cylinder. If, however, the exhaust valve is held up to a very slight degree, a reduced charge will be admitted, and the force of the explosion consequently minimised.

In the case of cycles, an exhaust valve lifter is frequently fitted, in order to enable the rider to effect an easy start.

(3) *Exhaust-Valve Closer*.—This system is adopted on the De Dion voiturette, and consists in regulating the lift of the exhaust valve, but does not prevent the valve from closing in the usual course. It is also used in conjunction with the sparking advance. When the maximum power is required, the exhaust valve is not interfered with, and opens to its fullest compass. When less power is required, the exhaust valve is prevented from opening to that extent. Consequently the exhaust gases are not fully expelled, and as they partly occupy the space in the combustion chamber, a full charge of mixture cannot be admitted through the induction valve, and the explosion is weakened.

(4) *By Regulating the Lift of the Induction Valve*.—By operating a lever, the induction valve is prevented from opening to its fullest extent, and consequently the largest possible charge is not admitted to the combustion chamber.

(5) *By mechanically Governing the Exhaust Valves*.—This is effected by preventing the cam from raising the exhaust valve after an explosion has taken place. This system is only adopted on two- and four-cylinder engines, and is the one in

most general use. The Daimler form is perhaps the most typical, and consequently we will proceed to describe it by means of diagrams. Briefly put, it consists in temporarily preventing one or more exhaust valves from opening, and consequently for the time being a fresh charge cannot be admitted into the combustion chamber, as the latter is charged to its fullest capacity with the exhaust gases. As already explained, the ordinary exhaust valve is opened by means of a plunger actuated by a cam on the two-to-one shaft (see fig. 6).

Figs. 14 and 15 show a side view of the mechanism which operates the Daimler exhaust valve. Taking fig. 14 first:— κ corresponds to the stem of the exhaust valve marked F in fig. 6, while the shoulder F is the plunger, which, acting upwards, pushes the valve open and so allows the exhaust gases to escape. R is a roller free to revolve on the spindle 2. B is the two-to-one shaft marked D in fig. 6, and L is the cam on this shaft corresponding to cam E in fig. 6. It is shown in dotted lines because it is not visible when looked at from this aspect. It will be seen, however, on shaft B in fig. 15.

Now, as shown in the illustration, the exhaust valve is closed, but when the cam L revolves another half-turn, the projection on it bears against roller R , and so pushes upwards the arm D , which is hinged on the spindle 1. Needless to say, the shoulder F is thereby raised, and in turn pushes upwards the lifting rod or digger κ , thus opening the exhaust valve.

We will now turn to fig. 15. This shows how the various systems of levers in fig. 14 operate so as to prevent one or more of the exhaust valves from opening, and so make the engine cut out on one or more cylinders by preventing the ingress of a fresh charge of mixture to the combustion chamber. It will be seen that the eccentric portion of the cam L is now uppermost, and is bearing against the roller R , so as to elevate the arm D with its shoulder F . In fig. 14 the end of the spindle κ , which is commonly known as the digger, rests on shoulder F , but in fig. 15 it will be observed that κ has been pushed outward by the arm J , so that the point of the digger

misses F. Consequently, instead of the valve being raised, it remains shut.

We shall now explain how this is accomplished. The arm H, commonly known as the hammer, is the direct medium through which this change is effected. It will be seen in fig. 14

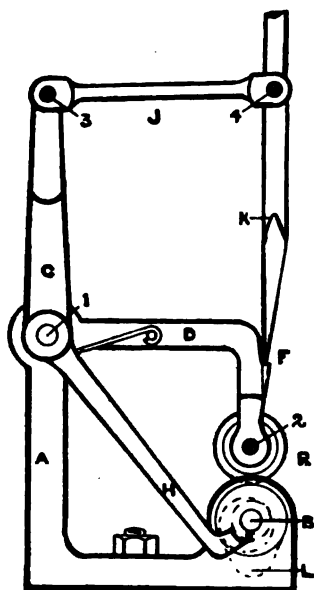


Fig. 14

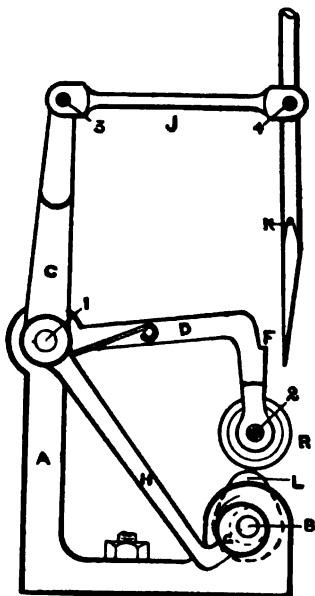


Fig. 15

A, frame carrying the bearings for two-to-one shaft B; B, two-to-one shaft; C, bracket forming portion of hammer H, and carrying connecting rod J, which operates the digger K; D, arm mounted on spindle I; E, circular collar on two-to-one shaft; F, shoulder on arm D, to engage digger K; G, eccentric cam on two-to-one shaft; H, hammer; L, cam operating exhaust valve; R, roller actuated by cam L.

that it rests on a perfectly circular collar, E, whereas in fig. 15 it has mounted on to a cam, G, which is fixed eccentrically on to the shaft B. This cam G is so mounted on shaft B, that when the protruding portion of cam L is pushing up the roller R, the hammer H rests on cam G, at the maximum

distance from the centre of shaft B. As a result, the hammer H is slightly depressed. Now H forms portion of the bracket C, and, consequently, when I is depressed it moves the bracket C slightly forward from the perpendicular, as seen in fig. 15. This, in turn, pushes forward the spindle K, so that the digger at the end of it misses the shoulder F, as shown in the diagram. A careful study of figs. 14 and 15 side by side, and the angles of the various arms and brackets, will show distinctly how their position is altered to accomplish the end in view. Fig. 17 shows a perspective view of the mechanism which will further help the reader.

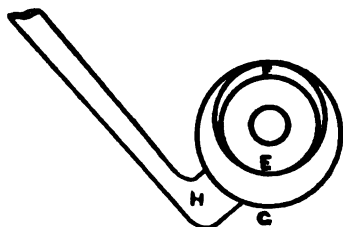


Fig. 16

H, hammer; E, circular collar, on which hammer rests when both cylinders are working; F, eccentric cam on which hammer rests when one cylinder is cutting out; G, eccentric cam on which hammer rests when two cylinders are cutting out.

Fig. 16 will assist the reader to understand the way in which the hammer climbs from cam to cam. It represents the end view of the two cams and the collar, with the hammer resting on the largest one, G. It will be noticed that their circumferences coincide at one point, thus enabling H to slip from one to the other with facility. E, the circular collar, is mounted truly on shaft B, whereas F and G are mounted upon it eccentrically.

We have now to describe the mechanism that operates the hammer H, and to show more clearly the cams on which it acts.

The mechanism which operates the hammer H is commonly known as the governor, and is clearly shown in fig. 17. This mechanism is attached to shaft B. In figs. 14 and 15 the

end of this shaft is shown, whereas in fig. 17 a perspective view is given.

The principle of the governor will be more easily grasped

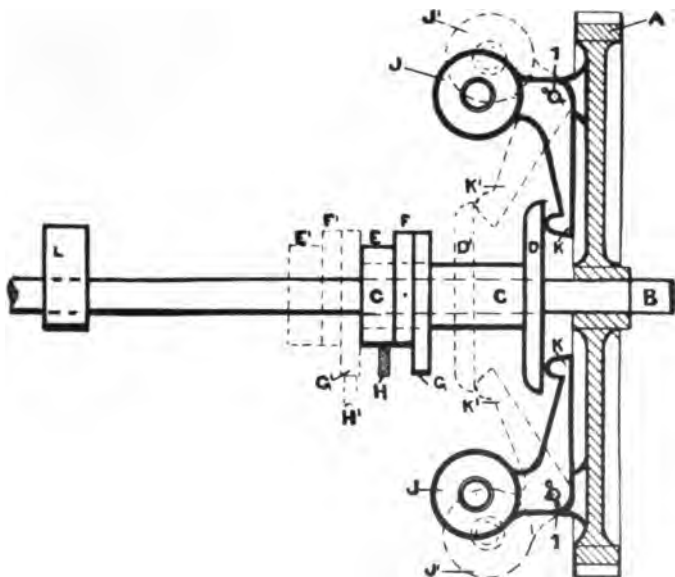


Fig. 17

A, gear wheel shown in section ; B, two-to-one shaft upon which A is mounted ; C, sliding sleeve upon B ; D, disc mounted on C, upon which the arms K, K act ; D', position of disc D, when both cylinders are cutting out ; E, circular collar upon which the hammer H rests when both cylinders are working ; F, eccentric cam upon which H rests when one cylinder is cutting out ; G, eccentric cam upon which H rests when both cylinders are cutting out ; E', F', G' show the position of cams E, F, and G when both cylinders are cutting out ; H, position of hammer when both cylinders are working ; H' position of hammer when both cylinders are cutting out ; J, J, weights attached to the arm K K, which fly out by centrifugal force and push C along shaft B ; J', J', position of these weights when both cylinders are cutting out ; K, K, arms carrying the weights J, J, which are pivoted at 1, and act upon D ; K' K', position of arms K, K when both cylinders are cutting out ; L, exhaust valve cam. A coil spring connects the weights J, J, with the object of offering resistance to centrifugal force, which is not shown in the diagram.

by making the following simple experiment. Attach a weight to a length of string, and, holding the end of the string, revolve the hand slowly in a circle. The centrifugal force will cause the

weight to fly outwards, describing a circle, and if the hand is revolved rapidly, the weight will fly still further out until the string forms a right angle with the perpendicular. Now *A* in fig. 17 occupies the position of the hand. It is a gear wheel attached to shaft *B* (the two-to-one shaft) and is operated by a smaller gear wheel on the engine shaft. *J, J* are two weights pivoted at one of the extremities of the gear wheel, and which of course are free to fly outwards when the gear is rapidly revolving.

Now we would ask our readers for a moment to look at the diagram irrespective of the dotted lines, as this represents the position of affairs when the gear wheel *A* is at rest. It will be observed that there are two arms *K, K*, which carry the weights and are pivoted at *I*. *C C* is a sleeve which is free to slide upon the shaft *B*, and on this sleeve *C C* are two cams, *F, G*, and a collar *E*, the latter being a true circle, and the other two eccentrics. *H* represents the end of the hammer as shown in figs. 14, 15, and 16. Now, so long as *H* rests upon the circular collar *E*, the exhaust valves open in regular sequence (see fig. 14), and neither cylinder is cut out.

We shall proceed to describe how the hammer *H* is influenced to slip on to the eccentric cams *F* and *G*, and so make one or both cylinders cut out.

We would now call special attention to the dotted lines in the diagram. The weights *J, J* are connected by springs regulated to the proper tension, but which, for clearness sake, are not shown in the diagram. When the speed of spur wheel *A* reaches the maximum pace at which the engine has been set, the weights *J, J* fly out until they assume the position *J' J'* as shown in the diagram. The ends of the arms *K, K* are thus moved forward until they assume the positions shown in *K', K'*, and in moving push against *D*, and consequently move the entire sleeve *C C* forward until *D* assumes the position *D'*, and the collar and cams *E, F*, and *G*, positions *E', F'*, and *G'*. The hammer *H*, not being free to move laterally, climbs in succession from collar *E* to cam *F*, and from cam *F* to

cam *c*, until it occupies the position *H'*, shown in the dotted lines. This position is also illustrated in fig. 16, but of course seen from a different aspect.

When the hammer *H* rests in this position on *c*, the arm *J*, fig. 15, is pushed so far forward that the diggers of the two cylinders both miss the shoulders *F*, *F*, and both exhaust valves remain closed, the speed of the engine immediately begins to slacken, and weights *J'*, *J'*, fig. 17, begin to return to their position of rest at *J*. Thereupon the hammer *H'* slips back on to the cam *F'*, and allows one exhaust valve to open, and one cylinder to come into action. If this is sufficient to run the car and engine at their maximum speed, as for example when descending a slight incline, the hammer remains there and only one cylinder works. If it is not sufficient, the weights *J'*, *J'* still further approximate to *J*, and the hammer slips back to the original position on the circular collar *K*, whereupon both exhaust valves open in turn, and both cylinders work at their full capacity.

L, shown further along shaft *B*, is the cam similarly lettered in figs. 14 and 15, which bears against roller *R*, and lifts arm *D*, which in turn raises the exhaust valve.

In figs. 14 and 15 we have only been able to show the way the cut-out motion works in connection with one cylinder. Fig. 18 depicts both, the lettering remaining the same.

As shown in this figure, *H* rests on the circular collar, and consequently neither cylinder will cut out. When *H* shifts on to the next cam, however, it is slightly depressed, as already explained, and thereby the arm *J* is pushed forward, and the digger at the end of *K* misses the shoulder *F*, whereupon the inner cylinder cuts out.

Seeing that the bracket *C* is in one piece, and is actuated by *H*, our readers will naturally wonder how it is that the further cylinder does not cut out at the same time. If they will examine the arm *J*¹ in the second cylinder, they will observe that it is divided into two parts, and that the outer part, *J*², telescopes into the inner. Consequently *K*¹ cannot be

pushed forward until the two shoulders of j^1 and j^2 come together. Now, when H mounts the third and largest cam, it is depressed to such an extent that the bracket c is moved forward until these two shoulders come in contact, and consequently both cylinders then cut out.

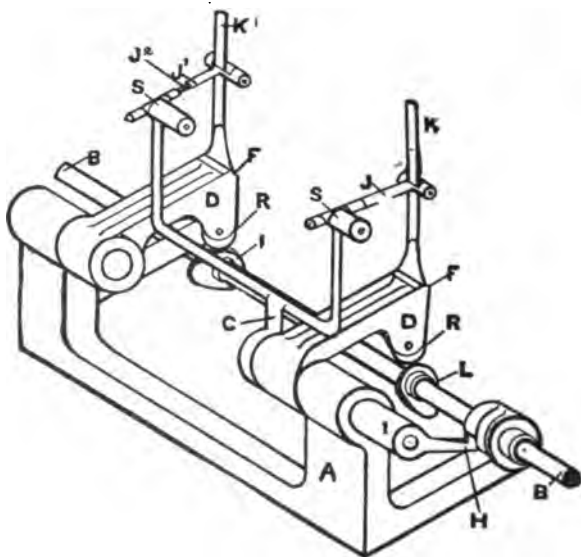


Fig. 18

A, frame carrying the bearings for two-to-one shaft B; B, two-to-one shaft; C, bracket forming portion of hammer H, and carrying connecting rods J and j^1 , which operate the diggers K and K^1 ; D, arm mounted on spindle I; F F, shoulders on arm D, to engage diggers K K; H, hammer; L, L, cams operating exhaust valve; R, R, rollers actuated by cams L, L; j^2 , telescopic rod sliding in j^1 . This allows one cylinder to cut out before the other. Not until the shoulders of j^1 and j^2 come together is the digger K^1 operated on; S, S, joints which allow the arms J and j^1 free up and down movement; I, shaft to which the hammer H and the bracket C are fixed.

There is one other bit of mechanism in connection with the governor which to prevent confusion we do not illustrate, and that is the accelerator. It consists of a lever which presses against the sleeve C C, fig. 17, and so opposes the action of the

arm *k* towards pushing the sleeve *c c* outwards. Now, the end of this lever is attached by means of a short coil spring, and a chain, to a foot or hand applied lever in the body of the car, by operating which the driver can increase or reduce the pressure on *c c*, and can consequently regulate the speed of the engine to any degree within the maximum and minimum limits, and so alter the speed of the car without changing the gears. For example, when travelling on a level road at top speed, if the driver wishes to slow down to pass a vehicle, he does not necessarily change his gear, but operates the accelerator, so as to alter the speed of the engine. The car will then slow until the pressure on sleeve *c c* is once more increased by means of the lever. Of course, in climbing steep hills, the engine, as a rule, will require its maximum power, and the accelerator must be operated to bring the greatest pressure possible on *c c*.

(6) *Governing by Throttle*.—This system has come into considerable vogue recently, and is now used on Panhard, Napier, Daimler, and other cars. It consists in controlling the speed of the engine by regulating the quantity of mixture admitted to the combustion chamber. This is not done by means of a hand lever, as described in (1) and (2), but is automatically worked by a governor, similar to that described in fig. 17, but simpler. The system being the same, it is hardly necessary to describe it at length.

The action of the governor arms operates a lever which in turn works a throttle valve situated in the supply pipe, close to the carburetter. This valve takes the form of a hollow plunger in which there are perforations, corresponding to similar apertures in the plunger slide. When the engine is working at its fullest power at maximum speed these apertures correspond, and consequently the largest amount of mixture passes to the combustion chamber. When, however, the work lightens and the engine begins to race, the governor comes into operation, and the holes in the plunger and plunger slide eclipse each

other to a greater or lesser degree, according as a greater or lesser quantity of explosive mixture is required.

The system is more economical of petrol, and gives smoother running than governing the exhaust valves.

(7) *Governing both by Exhaust and Throttle.*—This system is a combination of (5) and (6). The exhaust valves are governed as already described, but in addition a hand-worked throttle valve is fitted, which regulates the quantity of mixture reaching the combustion chamber. The valve generally takes the form of a plug which turns inside the supply pipe and cuts off the supply according as more or less is required. By means of this throttle petrol can be economised, noise reduced, and the smoothness of running increased.

MOTORS WITH MORE THAN ONE CYLINDER

Engines with two cylinders have the advantage of two impulses for every two revolutions of the fly-wheel, whereas a single-cylindereed engine only has one impulse for every two revolutions of the fly-wheel. The timing of the firing stroke depends upon the angle at which the cranks on the crank-shaft are set. This angle may be either 180 or 360 degrees. In the first, where the cranks are set at 180, though there are two firing strokes for every two revolutions of the fly-wheel, the two cylinders fire immediately after each other, so that during one revolution there are two impulses and in the next no impulse. If the cranks are set at 360, an impulse occurs every revolution, but an engine with cranks set at this angle must be balanced to counteract the extra vibration due to all the parts moving in the same direction at the same time. The diagrams will show the movements of two double-cylindereed engines, with cranks set at 180 and 360.

A four-cylindereed engine gives four impulses for every two revolutions of the fly-wheel, and runs even more smoothly than the two-cylindereed one.

In fig. 19 the sequence of events in the two cylinders, whose pistons are connected to cranks set at an angle of 180 degrees, is shown. In the diagram the circle represents the path of a crank-pin, and the piston is shown in its relative position. When at the top it is about to begin a downward movement, and an opposite movement when shown at the bottom. It will be noticed that when the piston of the

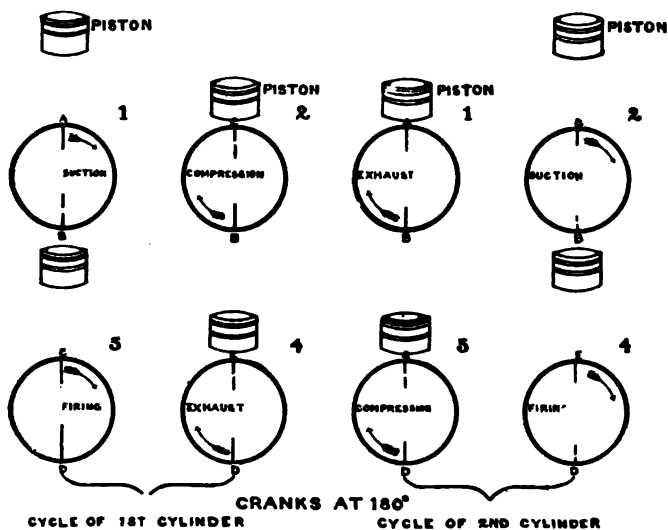


Fig. 19

first cylinder is on its first downward stroke (1) the piston of the second cylinder is on its upward stroke. Taking the sequence of the first cylinder from A to B (1) a charge is drawn in; from B to C (2) it is compressed in the combustion chamber; from C to D (3) the charge is ignited and a working stroke obtained; while from D to E (4) the burnt gases are expelled. In the second cylinder it will be noticed that the sequence is directly opposite to that in the first, and in order to make this clear

without particular reference to the diagram, the cycle is laid out as follows :—

First Cylinder

Suction
Compression
Firing
Exhaust

Second Cylinder

Exhaust
Suction
Compression
Firing

From the above it will be seen that one working stroke immediately follows the other, so that an even impulse is

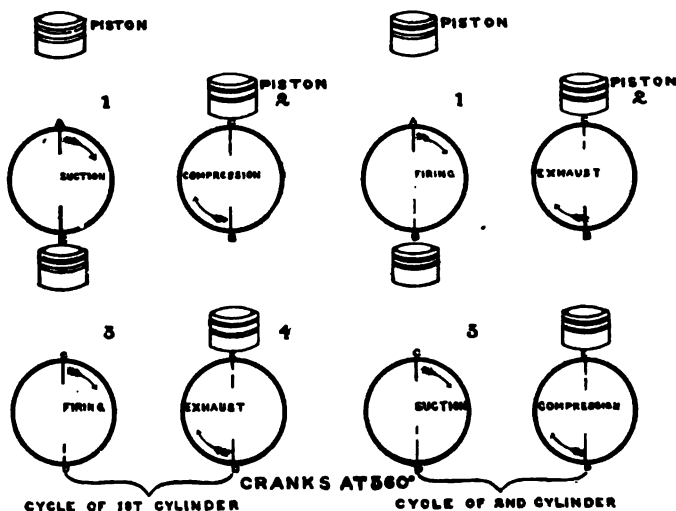


Fig. 20

obtained once in every two revolutions of the crank shaft, the other revolution being non-effective.

The second diagram, fig. 20, explains the cycle of events in the cylinder when the cranks are set at an angle of 360 degrees. It will be noticed that the two pistons 1, 1, are both about to commence a downward stroke, and that they consequently work together instead of opposite to each other, as in the

previous diagram. After the explanation of the first diagram it is unnecessary to go into the details of this figure, as the lettering and numbering correspond. The sequence in this case is :—

First Cylinder	Second Cylinder
Suction	Firing
Compression	Exhaust
Firing	Suction
Exhaust	Compression

In this case half a revolution occurs between the two working strokes, or, as previously mentioned, a working stroke is obtained every revolution.

WATER CIRCULATION

In the large motors, water is utilised to cool the engine, and it is essential that this water should be made to circulate so that the boiling water in the jacket will be displaced by cooler water, and the former cooled in radiators, before it is again used. There are two systems, viz. natural circulation and forced circulation, which we shall now proceed to describe.

In natural circulation the fact that cold water is heavier than hot water is availed of. A head of water is obtained by fitting a tank above the level of the water-jacketed cylinder, and as the water in the jacket is heated by the explosions, the colder water from the tank flows in, forcing the heated water in the tank to take its place, and thus an automatic circulation is set up. The connecting pipes must be so arranged that they offer every facility for the free circulation of the water, the cold leaving through a pipe at the bottom of the tank and entering at the lowest point of the cylinder, while the hot leaves the top of the cylinder and enters the tank at the top. The circulation, though automatic and certain, is slow, and for this reason requires a larger body of water to produce a given cooling effect than is the case with forced circulation.

Still, the certainty and simplicity of this method have distinct advantages.

In forced circulation a pump, either rotary or semi-rotary, is used, the direction of the flow being such that the water passes from pump to cylinder, thence to radiator, on to tank, and then through pump again, thus completing its circuit. The water in this way gets the maximum cooling effect from the radiator, and the body of water in the tank is kept cool. On account of the high speed of an oil engine and the comparatively small amount of power required to circulate the water, centrifugal pumps are becoming almost universal. As there are no valves to get out of order, and high speed is obtainable without extra gearing, this type of pump is very suitable. Semi-rotary pumps are also used, but necessitate lower speeds, and consequently extra parts to effect this. In the centrifugal pump the water is kept in motion by a fan-wheel working in an enclosed space; there being only just clearance for the fan, the centrifugal force thus obtained is utilised to project the water into the outlet pipe and up to the highest level of the system. In the semi-rotary pump a lifting force is obtained by means of the see-saw motion of a plunger with two valves working alternately. Another type of high-speed pump consists of two small gear wheels in mesh with one another in an enclosed space, with just sufficient space for their free revolution. The water is lifted and forced upwards by the intermeshing teeth acting in the enclosed as pistons.

RADIATORS

To enable the same water to be used continuously with little loss from evaporation, it must be cooled by some means; or in other words, the heat from the explosion in the cylinder absorbed by the water must be dissipated before that water can be used again, and the more perfect this dissipation is, the less body of water is required to carry on the car. To dissipate heat quickly, it is necessary to provide a large surface for the cooling medium to act on. As the air is the most con-

venient cooling medium, a continuous coil or battery of piping is placed on the front of the car, where it is most exposed to the current of air produced by the car in travelling. Through this coil the heated water is forced by the pump, the heat being carried off from the surface of the pipes by the air. In order to increase the radiation from the pipes, the area of the surface exposed to the air is increased by fitting flanges of thin metal in intimate connection with the pipes, or by originally forming the pipes with these flanges in the solid. Woven wire-work is also used, soldered to the pipes, with the same object.

THE CRANK CHAMBER

The crank chamber, or base chamber, as it is usually termed, forms the base of the cylinder. Its use for lubricating purposes is very important. About half a pint of oil is kept at the bottom of this chamber, into which the crank dips at every revolution, thereby splashing up oil which lubricates the wrist-pin, gudgeon-pin, crank bearings, crank-shaft bearings, the sides of the cylinder and the piston-rings. The lubrication of the latter is, of course, assisted by special oilers, which will be referred to later.

THE PISTON

The piston used in motor-cars is generally known as the trunk type. It is composed of an iron casting which is made a good sliding fit in the cylinder ; around its upper end three or four square-bottomed grooves are cut, and in these the piston-rings fit. The rings are made of cast iron, and the bore being eccentric to its outer diameter, there is a certain amount of spring in them, and so a gentle pressure is kept against the cylinder, preventing any of the expanding gases passing the piston. The piston is made to balance the crank.

Needless to say, the lubrication of the piston rings is of very vital importance, for on that depends the free working of the piston in cylinder. In single-cylinder engines, they

require frequent attention, and paraffin should be squirted down the compression tap at regular intervals. Occasionally, too, the cylinder head should be taken off, and the rings cleaned with a tooth-brush and paraffin. In double-cylinder engines, this constant attention is not required, for in addition to the splash system of lubrication, there are pipes running to the sides of the cylinders, through which oil drops constantly, and so keeps them lubricated. The speed of the engine, too, being so much less, there is not such danger of the oil being used up rapidly. Therefore it is as a rule sufficient to squirt paraffin every few days on to the top of the piston. Failing paraffin petrol is almost as effective.

RELATIVE POSITIONS OF INDUCTION AND EXHAUST VALVES

It was the general practice until a short time ago, a practice which is still in some cases continued, to place the exhaust valve directly under the induction valve. By this arrangement a simpler casting for the cylinder head is possible, as it only necessitates one opening for both valves. This system has now been improved upon by leaving the induction valves in their former position and making a second opening in the head for the exhaust valves. In the Daimler type of engine this alteration had a distinct advantage, for it enabled the exhaust gases to be got rid of at once (instead of, as previously, having to travel from one side to the other of the cylinder head), thus keeping the head much cooler and the induction valves free from the sudden and wide variations of temperature through the exhaust gases passing under them. This second opening in the head is also utilised to take the sparking plugs when electric ignition is used, as in this position they are constantly subjected to the scouring action of the exhaust gases which help to keep them clean and prevent any accumulation of carbonised oil to act as a short circuit.

APPLIANCES FOR STARTING THE MOTOR

The almost universal method of starting the motor is by means of a handle whereby the piston is operated and the charge drawn into the combustion chamber. In the case of cars with two or more cylinders various self-starters have also been introduced, which, on touching a button, explode the charge which remains in one or other of the combustion chambers, and so start the engine. These appliances, however, are only effective for a few hours after the engine has been running, as the charge escapes gradually.

VARIOUS TYPES OF ENGINES

There are various types of petrol engines on the market, but the main principles remain the same in all. The vertical engine is the most popular ; then comes the horizontal, and in other cases engines worked at varying angles. Once, however, the motorist has thoroughly grasped the principle of the petrol engine, there is little difficulty in understanding these varieties. The same series of operations take place in the small single-cylinder engine of the motor-bicycle as in each of the four cylinders of the 60 h.-p. racing car.

CHAPTER VIII

IGNITION IN PETROL ENGINES

BY J. ERNEST HUTTON, A.I.E.E.

It has been explained in a previous chapter how the reciprocating piston takes in a charge of explosive mixture and compresses it. It is now necessary to ignite this compressed gas in some manner, in order that an explosion may take place and drive back the piston with great force.

There are two methods of accomplishing this in the petroleum spirit motor, (a) by means of a hot platinum tube, which is known as 'tube ignition'; (b) by an electric spark, known as 'electrical ignition.'

TUBE IGNITION

The Platinum Tube.—At a convenient place in the wall of the explosion chamber a hole is drilled and means provided for attaching about it a nut, in the course of which is drilled a hole of sufficient size to take a platinum tube, closed at one end and provided at the other extremity with a flange. This flange must have a perfectly true face, and fit accurately against the face of the hole in the explosion chamber. Between the flange and the top of the nut is placed a thin asbestos washer; the nut being screwed up, the flange on the platinum tube is held tightly against the hole, so that any gas in the cylinder may have free access the whole way up the platinum tube, but none can escape at the joints.

The position for this tube is defined by the manufacturer so that at the time of greater compression the explosive mixture is forced into the tube and ignited.

The Burner.—To obtain satisfactory ignition, the platinum tube must be heated to a red heat. This is effected by a small Bunsen burner placed directly underneath. The burner consists of a small tube or 'stem' easily detachable from the petrol supply, in which is inserted a wick, composed of cotton rolled up in a sheath of fine brass gauze. The upper extremity of the stem is provided with a removable nipple, in which is drilled a minute hole. The burner is completed by a cowl, with a slot at the top which directs the flame on to the ignition tube. The burner is on the well-known Bunsen system, taking in air through holes at the foot of the cowl, the air being carried upwards with the jet of petrol coming through the small hole in the nipple.

Although there are numerous designs of burners on the market, they differ little from one another save in small details of appearance.

Petrol Supply to Burners.—There are two methods of feeding the burners with petroleum spirit :—

(1) By allowing the spirit to flow by gravity from a small tank fixed in an elevated position—this is known as 'gravity feed.'

(2) By forcing up the spirit from a tank—frequently the main supply—placed in a convenient position under the car by means of artificial pressure. This system is known as 'pressure feed.'

The advantages of gravity feed are its greater safety and perfect reliability. A good system of gravity burners will run for months without attention. The flame from a burner should be a bright blue, and directed lengthways on to the ignition tube.

NOTE.—In small Panhard cars the flame should be across the tube.

Gas-tight Joints.—Should a leakage of gas from the cylinder occur at the joint between the tube and the cylinder wall, it will greatly interfere with the working of the engine.

To detect if there be one, hold a match close against the joint where the tube enters the cylinder, at the same time turning the starting handle. As compression takes place, gas will be forced through any leak, and will show itself by blowing the flame of the match. If a little petrol be poured into the cylinder and the same method of testing employed, the leak will be detected by the escaping petrol becoming ignited.

It is essential that the nut which holds the platinum tube in its place in the wall of the cylinder should be kept perfectly tight, a special 'box' spanner being required for this purpose to give greater leverage.

Cracked Platinum Tubes.—It sometimes happens that the platinum tube becomes cracked, and thus allows the compressed gas to escape.

The same method as above may be employed to test this. If the tube be cracked, a new tube must be inserted, with a fresh asbestos washer. Never use the same washer twice. Care must be taken that the new tube is of the same length and quality as the old tube, to ensure accurate timing of the ignition.

• *Soot inside Platinum Tube.*—Faulty ignition is sometimes caused by the interior of the tube becoming blackened by sooty deposit, which prevents the gas becoming properly ignited.

Take out the tube and clear the interior with petrol and a little waste or rag. If deposit still remains, use a piece of fine emery cloth wrapped round a small stick.

How to Light a Burner.—The burner must be thoroughly heated in order to vaporise the petrol before it is allowed to flow freely through it, and for this purpose small cups are provided at the base in which methylated spirits can be burnt. A small oil-can may be conveniently carried on

hooks, provided for this purpose, inside the engine bonnet, to hold the methylated spirit required. Some automobilists dispense with the use of methylated spirits for the preliminary heating, and merely flood the burner with petrol allowed to run through gently, and setting alight to it keep the flame constant until the burner becomes heated. This method is to be deprecated, as very liable to ruin the paint on the engine bonnet.

Burners sometimes 'jump'—this usually happens when first lit and not sufficiently heated. Time should be allowed for them to become thoroughly heated before attempting to start the car.

How to Extinguish a Burner.—When putting out burners blow them out with a length of rubber tube and allow them to cool down until the petrol flows freely through them, then turn off tap.

Faulty Burners.—When the flame burns yellow or on one side, it is because the burner is choked by some foreign body lodging in the nipple, and preventing the spirit from having free exit.

The best remedy is to put in a new burner at once, which should always be carried ready for use ; the old burner may then be examined at leisure. When it is desired to remedy a faulty burner, the wick should be withdrawn and a 'pricker' run down the stem and out at the hole in the nipple, care being taken not to injure or enlarge the hole. Small particles of soot and dust in petrol are causes of trouble in gravity burners. When cold, and the petrol turned on for a moment, the jet should leap up straight at the tube ; if it quivers or is on one side there is something lodged in the nipple. The nipple must be removed and cleaned. Tight wicks, so frequently supplied by manufacturers, prevent the free flow of spirit ; loose wicks are useless, as they are at once pushed up to the end of the stem by the pressure of the petrol, and stop the hole ; the wick should be a good fit, neither too tight nor too loose.

Leakage in Pressure-fed Burners.—In pressure-fed burners, trouble is sometimes caused by leakage in the system of pipes, allowing the pressure to fall, or by water getting into them which has condensed in the pressure tank. *Caution.*—Before attempting to put a match near a burner, great care should be taken to be assured that the burner tap has not been inadvertently left on, and the engine box flooded. Many a good car has been burnt this way.

Burners Jumping Out.—Generally caused by too much pressure of petrol. The taps controlling the petrol supply to burners should only be opened a very little way—usually a quarter turn is sufficient.

Sudden bumps in the road will also cause jumping out.

Burners may also blow out. A proper wind shield should be fitted in front of the burner cage.

Spare Parts.—In connection with tube ignition it is necessary always to carry—

Spare platinum tubes.

Spare asbestos washers.

Spare nuts for tubes.

Spare burners.

Spare wicks.

Prickers.

A special spanner for undoing the nuts by which the platinum tubes are screwed into the cylinder.

A spanner for detaching burners from the supply pipe.

A spanner for removing the nipples of burners.

ELECTRICAL IGNITION

THE IMPORTANCE OF THE TIME OF IGNITION.—As we have explained above, the moment that maximum compression is reached the compressed gases are forced into the hot tube and become ignited. After each explosion a certain proportion of burned gas remains in the tube, and the rising piston causes

the fresh gas to mingle partially with this, but not sufficiently to ignite it until the greatest amount of compression is obtained. It is obvious, therefore, that with variable speed of engine, the moment of ignition is not always theoretically correct. In theory, that moment varies with the speed of the engine: many methods of timing 'tube ignition' have been suggested, but up to the present no satisfactory solution appears to have been discovered.

To get over this difficulty, and thereby greatly increase the efficiency of the motor, ignition by means of the electric spark has been devised. By the contrivance known as the shifting 'commutator'—afterwards described—it is possible to alter the moment at which the spark is caused to fire the charge in the combustion chamber, so that whatever the speed of the engine the moment of firing the charge is theoretically accurate.

Two Systems.—There are numerous types of electric ignition on the market, which may be divided up into the following classes:—

- (1) With a battery and induction coil.
- (2) The magneto system.

(1) **IGNITION WITH BATTERY AND INDUCTION COIL.**—The essential of this system is an electric battery. The function of a battery is to supply the necessary quantity of electricity to create the spark in the combustion chamber. Broadly speaking, there are two kinds of battery used for this purpose on automobiles—viz., the 'dry battery' and the 'accumulator' or storage battery.

The Dry Battery.—The dry battery, so called because of the absence of any visible fluid, has become exceedingly popular, because it requires little attention. Each battery is usually composed of four separate cells, coupled together by means of small pieces of wire. Each cell consists of a plate of carbon surrounded by a chemical compound, the whole being contained in a thin zinc case. The carbon plate forms one

pole of the battery, and is known as the 'positive' (+). The outer zinc case forms the other or 'negative' pole (-).

Poles.—When coupling up a number of cells to form a battery, the carbon of one cell is connected to the zinc of the next, and so on, until all the cells are connected, leaving one free wire at each end of the battery. These wires are known as the positive and negative poles of the battery.

Pressure of Electricity (Volts).—Each cell is capable of giving forth a certain small pressure of electricity. Pressure of electricity may be compared to the pressure of water in a pipe, or steam in a boiler, and is measured in units of pressure (volts) which may be said to correspond to pounds per square inch.

Flow of Electricity (Amperes).—Before, however, any current of electricity can pass out of the cell a complete 'circuit' must be formed between the two 'poles.' A quantity of electricity will then pass round this circuit in proportion to the pressure (volts) in the cell. This quantity or flow is measured in units known as 'amperes.' One ampere flowing for one hour is known as an 'ampere-hour' and the capacity of a battery is measured in ampere-hours.

Coupling in Parallel.—If the capacity of one battery is insufficient, two or more may be joined up in parallel by connecting the positive poles together and the negative poles together. To obtain a sufficient spark a battery must be capable of giving out a pressure of at least four 'volts.' For this reason it is usual to couple up four dry cells together.

Disadvantage of Dry Cells.—As we have explained, the utility of a battery depends on its capacity in ampere-hours. Every dry battery has a rated capacity, and once this quantity of electricity has been drawn from it, it becomes practically worthless, and a new one is required. The cost of these dry cells is very considerable, and if they are left for some time without work it not infrequently happens that the capacity has been seriously impaired owing to electrical leakage, which is

nearly always present in dry batteries. For these reasons the accumulator or storage cell is usually preferred.

Storage Batteries.—The great difference between a dry battery and a storage battery is that in the case of the latter when the battery is exhausted it can be completely re-charged in a few hours. The 'accumulator' or secondary battery may be briefly described as a number of prepared lead plates, immersed in a weak solution of sulphuric acid and water. These lead plates are alternately positive and negative, and are separated from one another by thin strips of ebonite, glass, or other non-conducting material. The whole is contained in a square cell of some suitable substance, which is unaffected by the acid. The positive plates, which are connected together, may be easily detected by their chocolate appearance. The negatives (slate colour) are also connected together, and convenient brass screws (terminals) are fixed, to which wires may be easily attached.

The capacity of each cell depends on the size and number of plates. The pressure of any cell may be taken at two volts when working. Two cells, coupled in series, are therefore required to make a battery of four volts.

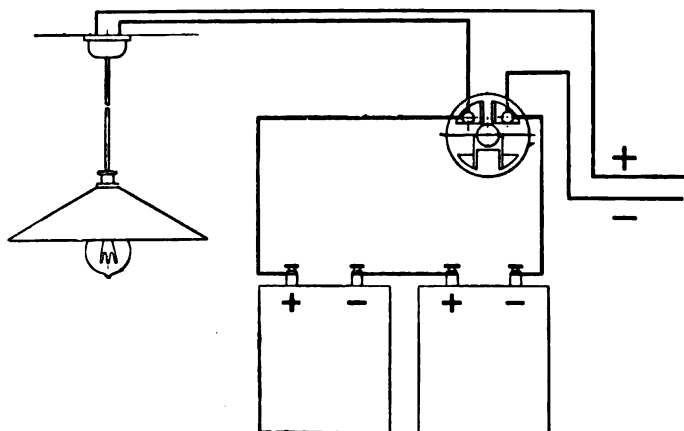
Charging Storage Batteries.—Accumulators require before use to be charged with electricity. This can be done by means of a large primary battery, small dynamo, or preferably off any continuous current electric light circuit. In any case it is absolutely essential that the positive pole of the cell should be connected to the positive pole of the generator, and the negative to the negative. The positive pole of an accumulator is usually painted red and marked thus, (+). An easy way of finding the poles of a generator or accumulator is by placing two small strips of lead connected to the battery wires in a tumbler of acidulated water, and after passing a current of electricity through them, the piece of lead connected to the (+) pole will become chocolate. 'Pole-finding' paper may be also used for this purpose.

How to Charge Storage Batteries from an Electric Light

Installation.—If a supply of electricity is available in the house there is a very easy way of charging off any wall switch (see diagram below).

The cell may be left on all night and found charged in the morning. No fear need be entertained of charging the accumulator too long. When fully charged the liquid in the cells assumes a milky appearance, and gives off a sound like gently boiling water.

Avoid Over-discharge of Batteries.—Great care should be taken to see that an accumulator is not discharged for a longer



period than its rated capacity. The pressure of an accumulator keeps practically constant at two volts per cell throughout the period of discharge. Immediately a drop in pressure is observed the cell should be recharged. Nothing ruins accumulators quicker than discharging them after the voltage falls. In no case should they be discharged to such an extent that the pressure of each cell falls below 1·85 or 1·9 volt per cell. The pressure may be conveniently ascertained by means of the instrument known as a 'voltmeter,' which will show at a glance the condition of any cell.

Care should be taken that the liquid in each cell well covers

the top of the plates. In process of time the liquid will be found to evaporate; this should be made up by a little clean rain-water, or preferably distilled water.

Switch.—It will be remembered that each battery has two free ends or 'terminals.' From one of these a wire is led to an 'interrupter' or 'switch.' This switch may take one of many forms. The effect of the apparatus is to easily and quickly complete or interrupt the circuit at any desired time in the same way that a tap is used to turn off water.

Induction Coil.—From the switch another wire is taken to an apparatus known as the 'induction coil.' The function of this is to greatly intensify the current. On a well-known electrical principle, the current, which is of low pressure (four volts), when it enters the coil, is intensified to a very great degree. The current being required to jump across a considerable gap inside the combustion chamber, a much greater pressure than four volts is essential.

To explain the method of connecting the coil with the battery and engine, it will be necessary to give a brief description of the coil. In the centre lies a bundle of iron wires, known as the 'core,' around which is wound a quantity of thick copper wire, insulated with silk or cotton. This wire is in one piece, and known as the 'primary' winding. On the top of this layer lie laps of very fine wire, likewise carefully insulated. This is known as the 'secondary' circuit. There is also usually contained in the same case an arrangement called a 'condenser,' which we need not describe. Although the two circuits are quite distinct from one another, a current of electricity passing round the primary and suddenly interrupted—by means hereafter described—will 'induce' a current in the 'secondary' of very great pressure. The ends of the two windings are led to the outside of the case, and terminate in screws or binding posts. These terminals are usually stamped with letters to indicate the method of connection. As many French coils are in use, it may help the novice to mention that the letter P stands for battery, M for commutator, B sparking plug, while in

the De Dion coils the brass rings on the outer case should be connected to the framework of the car, called 'earth.'

The Function of the Commutator.—Following the path of the current from the primary circuit of the coil, a wire is taken to the device known as the commutator. This takes many forms, which will be found under the description of the various systems.

The function of the commutator is to automatically make a break in the circuit, with the result that when the moment for firing arrives a flood of electricity at great pressure is induced in the secondary circuit.

The Sparking Plug.—In order to create a spark in the cylinder the wire from the coil is attached to a device known as the 'sparking plug.' This 'sparking plug' may be one of many forms, but all consist of a small central rod or wire, to one end of which is fixed a terminal to which the wire from the coil is attached. The other end takes the form of a knob or is bent at right angles. This conducting core passes through a tube of porcelain, mica, asbestos, or other non-conducting material, capable of resisting the great heat from the combustion chamber. The tube is fastened into a socket, easily screwed into the combustion chamber. The current flowing down the centre conductor finds itself compelled to jump a small gap to a piece of wire or other conductor let into the metal of the sparking plug. This jump gives rise to the spark which ignites the charge.

The Return of the Current to the Coil.—The metal of the sparking plug being in contact with the metal of the engine, the current is conducted from it to the coil.

This is usually done through the metal frame or pipes, which, of course, are good conductors of electricity. These connections are, however, a frequent source of annoyance. The wires are often attached to the frame by small screws, which shake loose owing to the vibration from the engine and uneven surface of the road.

It must be clearly understood that, although the wires, &c.

by which the circuit between the commutator and the coil is completed are technically known by the misleading term 'earth,' they are not used to convey the current to the ground but back to the coil.

Thus we have two complete electrical circuits acting in unison with one another. It is obvious that if there is any fault in the primary circuit no spark will be produced in the engine. Faults may arise from many causes.

Insulation.—Around wires intended to convey electricity are laid and woven many layers of rubber, cotton, &c. This lapping is to prevent the electricity which is being conducted by the wire from escaping, and is known as 'insulation.' On this 'insulation' the success of electrical ignition to a large extent depends, and the importance of keeping it perfect cannot be too greatly impressed on the novice.

The wires which convey the current from the coil to the commutator and from the commutator to the sparking plug have to be specially insulated, as the current, being at such a high pressure, will take every opportunity of leaving its legitimate path if allowed to.

All wires used for connecting the various parts of the systems should be very flexible, and composed of many strands of fine copper wire. Too much stress cannot be laid on keeping the insulation perfect.

If it be imperfect, the current will leave the wire and jump to the frame and thence back to the battery without performing the work required of it. When this occurs it is known as a 'short circuit.' Electricity always travels by the easiest path, and, if it can avoid doing any work, it will do so.

POSSIBLE DEFECTS IN ELECTRIC IGNITION.—*Imperfect Insulation.*—If a buyer has any doubts as to whether the insulation of the electric system of his car is sufficient under all conditions of weather and to withstand water splashed during washing the car, &c., he would save much trouble in the future by having all the important wires sheathed in fibre or indiarubber piping.

Probably ninety per cent. of ignition troubles arise from faulty insulation.

Insulation Burnt.—A wire placed too close to an exhaust pipe invariably fails after a time, owing to the insulation becoming burnt by the heat of the pipe.

Insulation Cut.—A loose wire hanging against a sharp edge will invariably chafe through in course of time.

Insulation of Coil.—If the insulation of the coil breaks down it cannot be repaired on the road, it must be returned to the makers. A small ticking is usually audible inside when this occurs, when the current is turned on.

Coils placed too near the engine are liable to break down, as the heat is injurious to them. They must be fitted in a cool place.

Insulation Chafed.—Wires laid across moving parts, brake connecting rods, &c., will sooner or later give trouble.

Loose Connections.—All wires when joined together should be carefully soldered, the joints being afterwards insulated with rubber or prepared tapes. Never make a joint in the secondary wire. See that all terminals are tightly screwed up. Special attention should be paid to the 'earth' connections, which are a constant source of trouble. When connecting insulated wire, the insulation must be bared back, so that only the bare wire is attached. Wires sometimes become broken, and being loose make partial contact.

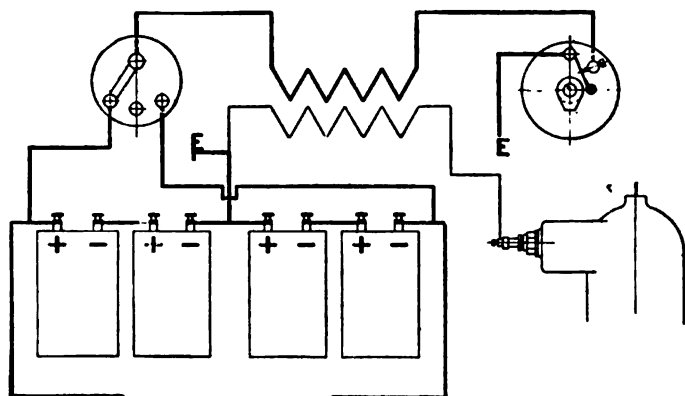
Dirty Connections.—Dirt is a non-conductor, and should be avoided on the electrical system, as on the rest of the car. Battery terminals frequently become corroded from acid fumes; they should be covered with vaseline, and require periodically cleaning. See that all connections at the coil are clean.

Broken or Defective-sparking Plug.—The porcelain may crack and the current jump across the fracture. The points may be sooty and require cleaning. They may be touching and require separating, or they may be too far apart. The usual distance between the points is about one sixty-fourth of

an inch, which is approximately the thickness of a thumb nail. An English firm has recently introduced a plug which contains no breakable insulators; this is an undoubted improvement, provided the insulating material employed is found to stand the strain well.

Dirty Commutator.—Clean all contacts from oil and dirt. Most commutators are so placed as to give the maximum possible opportunity to collect oil and dirt. They should always be provided with a cover.

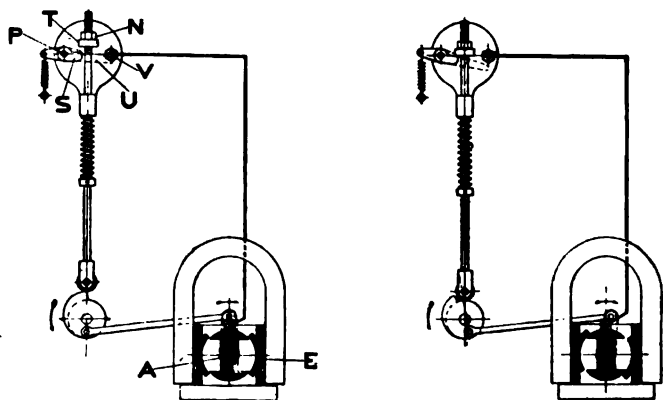
Batteries.—In course of time the batteries will become weak or discharged. Always carry a spare set. A two-way



switch should be provided on the car so that in a moment the spare set can be brought into use. The diagram shows the method of connecting up the switch, while both batteries may be charged together without interfering with the connections.

(2) **MAGNETIC IGNITION.**—From the list of possible failures given in the last section, it will be inferred that there are many faults liable to occur owing to the multiplicity of wires, batteries, coils, and the like. To obviate these difficulties, electricians have designed a little machine known as the 'magneto-generator.'

SIMMS-BOSCH SYSTEM.—Perhaps the best known of this type of machine is the ‘Simms-Bosch.’ The magneto consists of a number of horseshoe-pattern magnets supported on a metal base, on the inner faces of which are fastened two pieces of metal known as pole-pieces, provided with hollow faces, within which is fastened an H-shaped piece of soft iron (armature). The channels of this armature are filled with insulated wire. In the space between the armature and pole-pieces a ‘shield’ or tube of soft iron is caused to oscillate. To one end of this shield is attached a crank, operated by a connecting rod from the half-speed shaft on the engine.



When the shield is caused to oscillate rapidly, currents of electricity are induced in the winding of the armature. These currents are led away through a connected insulated wire to a special device which automatically makes and breaks a circuit in the interior of the combustion chamber. The action is as follows :—The wiper *u* is normally at rest upon the stud *v*, which is brought through the wall of the combustion chamber and terminates in a nut to which the wire from the magneto is attached. At the other extremity of *u* is attached a small rod brought through the flange and connected to *s*, which is capable of moving about a pivot *p*. This pivot is in electrical

connection with the other end of the armature-winding, through the metal of the engine. When the moment of firing arrives the striker *T* is caused to drop smartly on *S*, causing *U* to separate from *V*. At the same moment the shield *E* assumes such a position with regard to *A* that a current is induced in the windings on *A*, and being conducted through the connecting wire, a spark is caused to pass between the points of *U* and *V* igniting the charge in the engine.

POSSIBLE DEFECTS IN THE SIMMS-BOSCH SYSTEM. — (1) *Failure of Insulation.*—The stud which is brought through the wall of the combustion chamber has to be most carefully insulated from the metal flange in which it is placed. If this fails, the current will jump across to the frame of the motor in a similar manner to that of a broken sparking plug. The insulation is very liable to be burnt, and great care is necessary to make it good again. Thin washers of mica are used, but the intense heat generated in the interior of the combustion chamber appears to quickly affect it.

(2) *Failure of Magnets.*—After considerable use, the magnets are liable to lose their magnetism, thereby reducing the intensity of the spark. The only remedy is to return them to the makers to be re-magnetised.

(3) *Faulty Adjustment.*—It is obvious that the position of the shield at the moment of firing must be absolutely accurate, and when it is remembered that the working parts of this whole apparatus are moving at the rate of 350, or more, oscillations per minute, it may be seen that considerable wear is likely to take place, with the result that the parts get out of adjustment. The diagram opposite shows the relative position of the various parts, and, to assist the novice in accurately adjusting them, the following instructions are appended :—

Remove the top plate of the magneto machine by unscrewing the screws at the corners; the moving parts of the machine will then be open for inspection. Turn the engine gently round till the ignition point is reached, i.e. when the ignition rod drops, observing carefully the direction in which the oscillating

shield *E* of the magneto machine is moving; at this point the side of the envelope moving from the armature *A* should be clear of the same by about one-sixteenth of an inch. The setting can be done by varying the length of the magneto driving rod if adjustment is provided there, or if not by loosening the nut at the end of the magneto spindle and gently tapping the edge of the armature till the correct setting is obtained. The final adjustment should be made on the tappet *T*, which should strike the sparking lever *S* about one-sixteenth of an inch before reaching its lowest point, the exact distance being found by examining the spark (turning the motor smartly round for this purpose) and adjusting the tappet till the best spark is obtained. The lock-nut *N* should then be screwed up.

THE DAWSON IGNITOR.—As pointed out, in the Simms-Bosch system a mechanical interrupter is necessary in the combustion chamber, owing to the low pressure employed. To obviate this somewhat undesirable adjunct, Messrs. Dawson have introduced a high-pressure magnetic machine. The magneto itself generates electricity at low pressure, which is transformed by means of a special induction coil into a high-pressured current. An ingenious arrangement enables the current to be distributed to any number of cylinders without the necessity of more than one induction coil, and moreover allows the advancement of the spark throughout a complete revolution of the engine.

The machine is worked in conjunction with ordinary sparking plugs on the De Dion principle, and being self-contained can be quickly and easily fitted to any car. The magneto is driven off the main shaft of the engine, and at the same speed, by means of a chain.

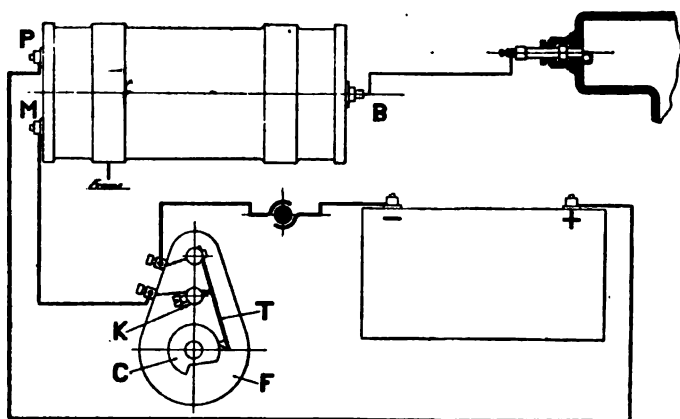
The motion being rotary, much less wear should be experienced than with oscillating machines.

Owing to the short time this machine has been on the market, it has been found impossible to obtain data as to its reliability in actual practice.

DE DION TYPE OF IGNITION.—We will now describe the ignition fitted to some of the best known types of engines.

De Dion et Bouton.—This well-known firm may be said to have set the fashion of electric ignition in the smaller engines. The system they employ belongs to Class I.

The most notable feature is the commutator. This device consists of a cam or disc *c*, fastened to the half-speed shaft of the motor, and provided with a wedge-shaped notch. Around the cam is attached a pear-shaped plate *F* constructed of good insulating material, such as ebonite, to which are attached a



spring vibrator or 'trembler' *T*, and a brass pillar in which is fastened a platinum-pointed screw *K*. The trembler is provided with a platinum stud or 'contact' about the middle.

The Action of the Trembler.—The action of this trembler is very simple. Normally the end of the trembler *T* presses on the cam *c*, the platinum contacts on *T* and *K* being a little apart. If the engine be now turned round until the time for firing the charge arrives, the trembler will be seen to fall into the notch in the cam, allowing the two platinum points to come

into contact. If the distance between the contacts is correctly judged, the trembler will vibrate freely, thereby causing several 'makes and breaks' in the circuit. As previously explained, a stream of sparks will result in the combustion chamber.

And, as also explained, it is necessary to alter the moment of firing the charge.¹ To effect this the plate *r* is designed to be easily moved backwards or forwards in relation to the cam *c*. The effect of this is to bring the point of the trembler a little higher up or lower down, causing it to enter the notch earlier or later, so that the moment of contact and consequently the spark is varied according to the will of the operator. The faster the engine runs, the earlier must be the spark.

HINTS ON WORKING THE DE DION IGNITION.—*Adjustment of Trembler.*—On the correct adjustment of the trembler and the screw *κ* much of the success of the De Dion system depends. The means of adjustment is as follows: Unscrew the sparking plug, and attaching the 'secondary' wire, lay the metal portion of the plug on the top of the engine, care being taken that the terminal is well away from any metal. Now smartly turn the motor starting-handle, when a stream of sparks should be observed to cross between the points of the plug. When the trembler is over the notch in the cam, it should have so far entered it as to be resting on *κ* when it is half in. If the bottom of the trembler be lifted with the finger and allowed to quickly drop there should be a regular hum or buzz. After a little practice the novice will be able to recognise the correct position for the screw *κ* by the hum of the trembler. It should be remembered that, though a stream of sparks may pass between the points of the sparking plug when it is removed from the engine, it does not follow that the same effect will be produced under the conditions of highly compressed gas found in the cylinder.

¹ So that it may accord with the speed of the engine, i.e. earlier in the engine stroke for high speed and later for slow speed.

Moisture is a frequent cause of trouble on motor-cycles. Rain or damp may lodge on the porcelain of the sparking-plug or between the terminals on the ebonite plate on the commutator, or between the terminals of the coil. *Remedy*.—Carefully wipe the affected parts with a dry rag and cover them with a little oil or vaseline.

Battery Short-circuited.—Spanners, oil-cans, tire-pumps, &c., have been known to jump on the top of batteries, thereby connecting the terminals together and causing a 'short-circuit.' *Remedy*.—Always carry the battery in a separate box, away from other things.

Burnt Contacts.—The contacts may become burnt. They should be cleaned up with a smooth file.

Loose Contacts.—The platinum points on the trembler can become loose. They should be knocked up with a light hammer.

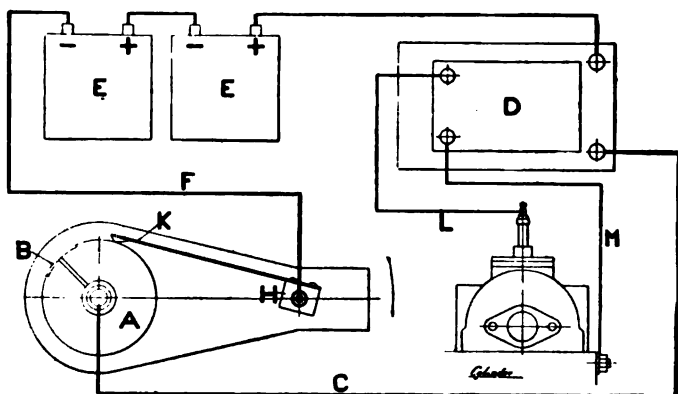
Oil on Contacts.—It frequently happens that oil and dirt accumulate on the platinum contacts, which interrupt the free flow of the current. Care should be taken, therefore, that they are perfectly clean.

Retard Sparking for Starting Engine.—When starting a motor the spark should always be placed as late as possible.

THE BENZ IGNITION.—This system is practically identical with that used by Messrs Panhard-Levassor, Daimler Co., Napier & Son, &c. While the general lines of the De Dion have been followed, one important variation is introduced—viz. the alteration in the position of the trembler. In engines running at a lower speed than 1,000 revolutions per minute the De Dion is not found to answer satisfactorily, and a different method of causing a vibratory contact had therefore to be devised. On the Benz system the notched cam is replaced by a round fibre disc A, a brass strip (B) being attached to it over one-eighth its circumference. This strip is connected with the iron axle on which the sleeve revolves. A spring (H) to which is attached a knob, K, rests upon the disc. A wire connects it with the battery. It will be seen then that as the disc revolves

the plate *B* will pass beneath the spring *K*, thereby completing the electrical circuit from the battery through *K*, *B*, and on to the metal of the motor, whence it returns to the coil. To effect the rapid interruption of the current a trembler is provided on the coil. The action of this is as follows :—

When a current is allowed to flow round the thick or primary winding of the coil, the iron wires, which it will be remembered composed the core *T*, become magnetised, and attract the iron knob *R* of the spring armature. The current for this purpose is led through the screw *S* to a platinum point



on *R*. The moment this occurs the contact-piece on *R* leaves the point of the screw *S*, with the result that *T* instantly loses its power of attraction; this action is repeated with great rapidity so long as the circuit is completed by *B* and *K*. The screw *S* requires to be adjusted in just the same manner as *K* in the De Dion system, though it must be remembered that the action is reversed, the trembler being in contact with it so long as *B* and *K* are apart. In engines provided with two or more cylinders an easy method of testing the spark in each cylinders becomes apparent. In most systems a separate coil is required for each cylinder. Having put the engine in motion,



depress with the fingers all the tremblers except one, allowing each trembler to vibrate separately. Should there be a faulty cylinder, it will at once become apparent, and the cause easily located.

The commutator used on the Napier cars has been placed in front of the driver and covered with glass, so that the sparking at the points is easily viewed. A chain driven off the half-speed shaft causes the centre disc to revolve. A special form of contact is used, which possesses the great advantage of being unaffected by oil. In other respects the system closely follows the Benz.

The Canstatt Daimler Co., Messrs. Mors, &c., are at present using the magneto system.

MORS MAGNETO IGNITION

The following notes on the Mors ignition have been kindly supplied by Lord Cairns:—

The magneto ignition system, which is applied to all the new model motor-engines of M. Mors, consists of a magneto-electric rotary machine, combined with a series of mechanical contact-breakers.

The magneto-electric machine is bolted to the frame, and driven direct by the gear wheel of the valve cam shaft, which engages with a small pinion on the armature spindle. This pinion is a quarter the diameter of the gear wheel of the cam shaft, and the armature therefore revolves four times to each revolution of the cam shaft, or twice to every revolution of the engine. As two cylinders out of the four fire in each revolution, the magneto thus revolves once for each spark obtained, the correct relative position of the revolving armature being geared to agree with the successive breaks of contact, which being operated by a set of cams on the cam shaft, are thus kept in 'time' with the moments of greatest generation or current.

The breaks of contact are produced in the explosion

chambers by small rocking arms, called the palettes, of which the inside arms are alternately pressed by springs against the surface of the ignition plugs or 'inflammateurs,' and then removed by the action of the cams, the vertical stalks from which lift and hold lifted the outside arms of the palettes.

The action is as follows:—In each cylinder during nearly two engine revolutions—that is, from the moment of its firing until the moment of its next compression approaches—the cam is holding up the outside arm of the palette, and therefore keeping the inside contact broken. As the piston rises during compression, the cam stalk descends and contact is made inside, but the spark of course does not pass until it is again broken. The cam stalk continues to descend until its top is a certain distance (2 mm.) below the outer arm of the palette. It then rises again and strikes the outer arm sharply, breaking contact within, at the identical moment that the magneto being at its 'tight point,' is prepared to give off most current. This occurs in each cylinder in rotation, and as only one contact and break are made at a time, it is evident that one wire only from the magneto is required, and is clamped to the outer ends of each of the four insulated plugs or inflammateurs, with the usual earth return through the frame.

The magneto and contact-breakers, being both thus 'timed' together, through the medium of the cams and gear wheel on the cam shaft, it is in practice only necessary to observe two important points: First, the magneto pinion has a definite position in gear with the cam shaft gear wheel, and should it at any time be necessary to disconnect the magneto, the teeth should be marked. If this is not done it takes a little trouble to find the timing again, but a few turns of the starting-handle trying the teeth in different positions of gear, soon discovers the best position. Secondly, it is important that the distance that the cam stalks descend below the outside arms of the palettes should be maintained at about 2 mm. (the thickness of two halfpennies). A small difference in this distance will not much affect the magneto spark, but it does affect the

advance of the firing ; and the shorter the distance the more advanced it becomes, the cam stalks in rising covering the reduced distance and breaking contact the sooner. And the tendency is in this direction, for after running a thousand miles or so, small craters become burnt away on the under surface of the ignition plugs, where contact occurs, and the inside arms of the palettes, in rising to fill these, bring down the outside ends and reduce the distance. In practice this is no particular disadvantage, down to about $1\frac{1}{2}$ mm., but below or even at that distance, a sharp back-fire may be experienced on the starting-handle, or if the engine be kept running very slow on the throttle valves, the motor may possibly be stopped. This distance should therefore be verified at intervals, and if necessary restored, which is done either by bending upwards the outside arms of the palette with the pliers, or by putting in a new set of ignition plugs, when the craters may be removed from the old ones by filing flat, and turning a corresponding amount off the flanges. This amount rarely exceeds $\frac{1}{2}$ mm., and the plugs are then as good as new. Even in this case the palette outside arms have generally to be slightly bent, up or down, as the case may be, and it will save a lot of trouble to adjust the distance at 2 mm., and never to go below $1\frac{1}{2}$ mm. When a new adjustment has been made, the cocks in the cylinder heads should be opened successively, just to see that each cylinder is firing equally and clean.

Should any difficulty be experienced in starting, and should the other parts of the engine be apparently in good order, the following may be looked at for the cause :—

The armature spindle ends may be examined to see that they are clean, and therefore in good contact.

The ignition plugs may be examined to see that they are not coated with oil, which would prevent a proper contact with the rocking arms. This may occasionally happen if too much oil has been allowed to accumulate in the crank chamber.

The little plug-hole on the dash-board, into which a

removable plug is fitted to complete and break the circuit, should be looked at. If it should be very rainy weather, a drop of water may possibly get between the contacts, which are seen held apart when the plug is in place, and so complete the short circuit arranged to take place only when the plug is removed. This can be dried, or a drop of oil as an insulator squirted in between the contacts.

If at starting, one or even two cylinders can be heard missing fire, a few revolutions at a good speed will generally set them going again : if not, it may be necessary to remove and examine the ignition plugs of the defaulters.

The magnetic ignition has been found to work extremely well ; and to give very little trouble, if these points are attended to. The magneto machine itself seems, and is, inexhaustible ; and the space otherwise required for batteries and cells is all saved. It also gives a fine 'fat' spark, which adds to the efficiency of the explosion. It probably gives a little more noise, if the motor-car is standing still and the engine running very slow on the throttle valves, owing to the firing being always so much advanced ; but many of these engines have now the ordinary hit and miss exhaust governor as well, so that the throttles need not be closed so much, and a higher speed allowed. It is, after all, a question of which kind of noise is preferred.

The button on the steering-wheel is arranged to produce a short circuit when pressed, and so stop the firing of the charges in the cylinders. This system in practice is in many ways a great convenience. It can be used in many cases instead of the clutch, and with much less labour, always remembering that the car must not be brought to a standstill by the button, or the motor is stopped. As a brake downhill, it may be used as a slight, or if the gear be on the lower speeds, as a strong compressing brake, and without heating anything ; or on a long hill, the engine may be unclutched and stopped altogether and only restarted at the bottom by letting the clutch gently in again. This is not important

perhaps, but sometimes a convenience in hot weather, and always some slight economy of spirit, and lastly, in changing gear, the button may be used at the same moment as the clutch with a very quiet change as the result.

The magneto machine seems thoroughly trustworthy. The writer has carried a spare one for many thousands of miles, but never had occasion to use it, the original one having apparently never failed in a single spark.

CHAPTER IX

THE CAPRICES OF THE PETROL MOTOR

BY THE HON. CHARLES S. ROLLS

THE intending owner of a motor-car will often say, 'What in the world should I do if the thing were to break down on a country road?' and the object of this chapter is to enable the novice *en panne* quickly to recognise the symptoms of his case (so far as the engine is concerned) and then at once to 'spot' the probable cause and remedy.

In order to make these remarks complete, I have been compelled to enumerate a very long and somewhat formidable list of evils, and lest a glance at this should frighten off any would-be motorist, it must be clearly understood that the list comprises *possibilities* as distinct from *probabilities*.

What is here said should therefore be looked upon in the same light as a veterinary surgeon's book on horses, and readers must not think that if they purchase cars all the troubles here mentioned would necessarily occur to the motor any more than they would imagine that all the diseases described in a horse-doctor's book would happen to a newly acquired horse. Many cars have been run by amateurs for thousands of miles without the occurrence of any trouble. In proof of this I may observe that a member of the Automobile Club recently stated that, although he had previously no engineering experience, he had run his car ten thousand miles without having to effect any serious repairs, and had experienced no trouble whatever except on two occasions, when the slight repairs necessary were done in a very short time.

The chapter is divided into two parts, the first dealing with the 'Difficulties in starting,' and the second with 'Troubles on the road.'

PART I

THE MOTOR WILL NOT START

A petrol engine will generally start most easily with all the cold-air inlets closed, the usual procedure being to shut these air-holes or taps, then let a little petrol into the carburator, shake the float needle (if there be one) or inject petrol into the induction valves or through the compression tap on top of the cylinder, if such exists; then, the ignition tubes being red-hot, or the electricity switched on and ignition retarded, a few turns of the engine should suffice to set it going; if, however, it will not start, the trouble must lie in one of the following sources:—1. Ignition; 2. Carburation; 3. Compression; or 4. Moving parts.

1. *Ignition*.—Having satisfied yourself that the ignition is in perfect order (see Chapter VIII.), the fault must be in one of the three sources remaining.

2. *Carburation*.—Let us first take the Carburation. There are many little things which may militate against a healthy explosive mixture reaching the cylinders, and we will first enumerate the principal causes in brief as follows:—

- (a) Wrong proportions of air and gas.
- (b) Carburator flooded.
- (c) Carburator starved.
- (d) Cold weather.
- (e) Stale petrol.
- (f) Handle not turned fast enough.

To deal with these more fully:—

(a) The mixture of hot air, cold air, and petrol vapour should be varied in every possible way—see that an excess of air is not being drawn in through a crack in a pipe or loose coupling.

(b) Too rich a mixture may be caused by the presence of too much petrol in the carburator ; if this is so, turn off the petrol supply for a time and revolve the engine again with all air inlets wide open until the first explosions are obtained.

(c) Perhaps the cylinder cannot get any petrol vapour, owing to the nipple (in a float and jet type carburator) being stopped up. This nipple can be taken out with a special key and cleaned by passing a fine needle through it, taking great care not to enlarge the hole in the least degree. Possibly there is no petrol in the tank, or you have forgotten to turn it on, or the tank is almost empty and the car tilted by standing at the side of the road ; push it over to the other side. One can tell if there is any petrol in the carburator by the position of the float needle, and the novice should provide himself with a diagram of his carburator.

(d) In cold weather, if the car has been standing idle for some time, considerable difficulty may be experienced in starting up. Petroleum spirit will of course vaporise far less readily at a low temperature than at a high one. Artificial heat is therefore the remedy, and this can be most easily applied by taking out the mushroom-piece in the carburator (if there is one), and warming it over the burners or otherwise ; or warm petrol may be squirted into the cylinder or induction pipe or valve. In obstinate cases it may be necessary to warm the carburator underneath by means of a little cotton waste soaked with methylated spirit. There may be a slight flare up, but this will assist the carburation, and there is nothing to fear from it so long as the main supply cock has been carefully closed.

(e) *Stale Petrol.*—The petrol remaining in the carburator may lose its strength if the car has been standing a long while ; it should be emptied out and refilled. A good plan when about to put away the car for some time is to stop the motor by turning off the main cock, so letting it use up the last drop of petrol in the carburator.

The petrol in the main tank may also become heavy in course of time, especially if free access of air is allowed to it. A small instrument called a densitometer is sold for determining the specific gravity of petrol ; the best specific gravity for starting is .680 ; if your petrol when tested shows heavier than sp. gr. .700 it should be changed or the tank shaken up.

(f) Perhaps there is nothing wrong after all, except that you do not turn the starting handle fast enough to cause vaporisation. Remember that a few smart turns with the whole of your energy

will be more likely to start an engine than hours of slow 'grinding.'

3. Having now ascertained that neither the Ignition nor the Carburation is to blame, if the motor still will not go we must look for the failure in either the compression or one of the moving parts.

Compression is the life and soul of a modern high-speed internal combustion engine.

When the engine is in proper working order, and being turned by hand, a considerable resistance should be felt at the alternate back stroke of each piston ; this back pressure should require a considerable effort to overcome when the handle is being turned slowly. If the compression of any cylinder leaks, that cylinder will not give off its full power.

How to Locate a Leak of Compression.—If there is a loss of compression, a slight hiss will generally be audible when the handle is turned. In order to find out where the leak is, a lighted taper may be held over the cylinder in different positions, while the engine is being turned slowly ; the flame will be turned on one side on meeting the leak ; or soap and water may be painted about the cylinder head, and bubbles should soon indicate the presence of the leakage.

Possible Sources of Leakage.—(a) A leakage will generally be found at the junction of such fittings as the ignition tube, induction valve, valve cover, sparking plug, compression tap, or other attachment connected with the interior of the cylinder or combustion chamber—probably a washer blown out or a nut loose will be the cause.

Should, however, the leakage not reveal itself under the above tests, it is probable that

(b) the exhaust or inlet valves are 'pitted' or coated with deposit, and consequently permit a loss of compression past their seating ; if this is so, they should be taken out and ground on their seats with fine emery powder and oil, or paraffin, till they bed properly ; the engine may then have to be run for some time before the leakage ceases. See also that the valve springs have not grown too weak.

(c) There is a possibility of the compression also blowing past the piston-rings. This can generally be detected by listening attentively with the ear close to the cylinder at fault, and turning the starting handle or fly-wheel slowly—a gentle hissing will be heard at intervals. The cause of this is generally the sticking of the rings in their grooves. The remedy is to wash out with paraffin so as to free them for their whole circumference. If they still leak badly, the piston should be taken out and new rings fitted, especially if the engine has been over-heated at any time, in which event

(d) the cylinder-head joint, if there is one, may have warped and the compression may be escaping from one cylinder to the other, and into the water space; water in turn will probably find its way into the cylinder, and being converted into steam, will interfere with the working of the engine and rust the valves. Little spots of rust on the valves will indicate what is happening, and the cylinder-head joint will then have to be re-made—a matter for an expert.

No Compression at all.—If on trying to start the motor no compression at all is felt on one cylinder, there may be a valve stuck open through a breakage or gumming (see later), or else the ends of the piston-rings may have by chance arrived opposite one another, thus allowing the compression to slip through the spaces. When this occurs, the rings should be freed by letting in paraffin and running the engine a bit on the other cylinder or cylinders if possible; the rings will probably soon change their position—they are purposely allowed to move round so as to wear evenly.

Apparent Excessive Compression.—There may, especially on a cold morning, appear to be so much compression that the engine can hardly be turned; this stiffness is really due to the drying of the oil on the walls of the cylinder. To avoid this a copious dose of paraffin should always be injected when stopping the car after a day's run, and a few turns given to the engine by hand.

Note.—It is most essential for every motorist to insist on having proper and convenient means fitted on his car for washing the cylinders with paraffin or petrol, both to facilitate starting up and to keep the piston-rings in good order.

Back Firing.—I have said that a considerable resistance should always be felt when turning a motor slowly by hand ; sometimes, however, the innocent motorist, when endeavouring to put his engine into motion, receives something considerably more than a mere resistance. He may get a kick from the handle which will give his arm a nasty jar, or possibly sprain his wrist. These 'back fires' are the result of what is called 'premature ignition,' and therefore belong strictly speaking to the chapter on 'Ignition.' I may merely remark that they are due to the spark-timing gear being too much advanced, the platinum tubes being too long, the burners being too close in, faulty opening of the induction valves, overheating of the motor, or ignition tubes being too hot ; in the last case the burners may be turned down to allow the tubes to cool momentarily and turned up again when the motor starts. In the other cases the remedies are obvious.

4. *Moving Parts.*—Having exhausted the possible causes of refusal to start except those consisting of some mechanical fault, we will now see what moving parts could go wrong, and so cause all the trouble.

(a) The mechanism for operating the electric ignition is liable to many little derangements (see Chapter VIII.).

(b) A broken exhaust-valve stem or a broken or displaced spring will often be difficult to observe ; a valve may have stuck open through stiffness or through something getting under its seat. The exhaust-valve gear should be carefully watched to see that all the valves work regularly and to their full extent.

(c) Stiffness in the accelerator or governing gear, or a dislodged key, pin, or feather may also hinder the lifting of the exhaust valves, or on some engines prevent the throttle from opening itself fully.

(d) The simple mechanism adopted on some cars to engage the starting handle with the motor will sometimes give out, so that the handle will not turn the motor. In cars of the Panhard type the handle is made to engage with the engine by pushing a small bevel-ended tongue in against a small pin put

through the end of the crank-shaft ; a bad ' back fire ' may cause this pin to sheer off or bend and jam the tongue. The novice should be shown the way to get at this mechanism so as to know how to renew the pin or tongue. If the starting gear fails at an awkward moment, the car may be started by putting in the third or fourth speed and pushing the car with the friendly aid of a few lookers-on.

PART II

ROAD TROUBLES

We will now pass on to Part II., dealing with possible troubles encountered on the road, dividing this section into—

1. Motor stops.
2. Motor nearly stops and then goes on again.
3. Motor will not pull well.
4. Motor will not govern or ' cut out ' properly.
5. Unusual noises.

MOTOR STOPS COMPLETELY

This may be divided into—

- A. Overheating.
- B. Starvation of carburator.
- C. Carburator flooded.
- D. Burners going out.
- E. Mechanical reasons.

A. *Overheating*.—The most serious cause of a stoppage on the road is undoubtedly overheating, which causes the lubrication to burn up and the piston to expand and grip or ' seize ' in the cylinder. This matter of overheating should now be divided into its various causes, viz. :—

- Cause 1. Water circulation stopped.
- „ 2. Water all lost.
- „ 3. Faulty lubrication.

- | | |
|-----------------------------------|-----------------|
| Cause 4. Water entering cylinder. | } very unusual. |
| „ 5. Too powerful a charge. | |
| „ 6. Incrustation of jackets. | |

Cause 1. Water Circulation Stopped.—Of these the cessation of water circulation for cooling is the most important. It must be the result (a) of the pump ceasing to act through bad adjustment of its driving-gear, or through its valves or cogs jamming; its spindle being seized or bent; the interior fan worn or unkeyed; the friction wheel unkeyed, or its tyre worn out or come off.

As regards the adjustment of the driving-gear of a centrifugal pump driven by friction, the friction wheel and spindle should revolve freely when the pump is pulled away from the fly-wheel. It should be adjusted so that the spring presses it lightly but firmly against the fly-wheel; care should also be taken in packing the glands of these pumps, for they run at a very high velocity; a very slight leak of water, however, is advantageous for lubrication.

(b) The blockage of a water-pipe or passage will also impede the circulation, or

(c) There may be an air or steam lock in the pipes. The best way of getting rid of an air lock is to open all cocks and plugs in the water system and run the engine, filling up the tank and water jackets to make up what is running out. This will eventually expel any air, and the water will circulate freely.

Cause 2. Water Lost.—If all the water has been lost on the road through the breakage of a pipe or the opening of a plug or tap, or loosening of a joint, and no water is near, you can continue your journey spasmodically by allowing the engine to cool down, then run on a mile or two with the bonnet open or off until it shows symptoms of overheating again, when stop, paraffin your cylinders, and wait another half-hour. The pump of a car has several times been known to have been carried away by contact with a dog; in one case there was no trace of pump or dog except a tooth which the unfortunate animal left in the back tyre.

Note.—Always carry rubber tubing to repair ruptured pipes.

Cause 3.—If the overheating has been caused by *faulty lubrication*, it is probable that this is due to inattention to the lubricators.

Remarks as to Lubrication.—It should be ascertained from the makers how many drops a minute are required for the proper

lubrication of the engine and it must be remembered also that in cold weather when the oil is thick a different adjustment will be necessary from that found suitable in warm weather. It is most important that the lubrication should be regular, and with good oil but not too much ; for too much oil will spoil the sparking plugs, clog the valves, and interfere with the explosive mixture. For this reason the lubricators should always be carefully closed when stopping. If a Dubrulle mechanical lubricator is used, examine the ball valves sometimes, and do not trust entirely to the sight feed. If a pressure type lubricator is used, see that the stopper is tight, for if the pressure from the exhaust leaks the lubrication will stop and in some cars the supply of petrol too.

It sometimes happens that an oil pipe or hole is stopped up and wants cleaning, or perhaps the plug at the bottom of the crank chamber has come unscrewed with the vibration and dropped off, losing all the oil, in which the cranks should always dip. The proper amount of oil for each crank case is generally at least half a pint ; an extra lubricator to the cylinders or base chamber should always be fitted, so that a little extra oil can be fed in by hand, if there is any doubt about the engine getting enough.

The following are additional causes of overheating. They are, however, of very rare occurrence :—

Cause 4.—The head joint may leak and admit water into the cylinders.

Cause 5.—In some engines if the throttle is kept full open, so as to admit too powerful a charge of gas, overheating will result.

Cause 6.—Finally, a thick incrustation on the walls of the water jacket, due to the use of bad water, will prevent the cooling water from taking up the excess of heat from the cylinder.

Remarks on Overheating.—*How to tell when a Motor is Overheating.*—The symptoms are :—

1. The driver can generally detect a slight smoke rising from the engine, and a smell of burnt paint and burnt oil.
2. A peculiar tapping sound becomes audible.
3. The engine will continue firing for a few revolutions after the current has been switched off or the burners extinguished.
4. Steam issues from the cooling water or the water blows out of the overflow pipe.

What to do when the Motor Heats.—As soon as any of the above symptoms are noticed—

- (1) The motor should be stopped at once.
- (2) Paraffin should be copiously injected into the cylinders and the engine turned by hand to free the piston-rings.
- (3) The parts should then be allowed to cool.
- (4) Change the exhaust springs.

N.B.—Do not pour cold water into the cylinder jackets, for fear of cracking them, but rather pour into the tank so as to warm the water before it reaches the cylinders.

Dangers of a 'Seize.'—Overheating of the engine to this extent should be guarded against, for it is liable to cause scoring of the cylinder walls, and may warp the cylinder-head joint (if there is one), which will necessitate re-making the faces—a tedious and difficult task. The exhaust-valve lifters may become bound, the excess of heat will also cause the valve-springs, piston-rings (and possibly the occupants of the car), to lose their temper; apart from the above no damaging effects are usual.

Precautions.—To enable the driver to verify the water circulation a 'manometer' should be placed on the dashboard to indicate the pressure of water, or a tap or float arrangement may be connected with the piping, so as to show whether the circulation is all right. During hard frost this is especially important, for should the circulation cease, the radiator, a pipe or even the water-jacket itself, may be easily burst by the frost.

B. *Starvation of Carburator.*—A motor may stop from other causes besides overheating—for instance, no petrol may

reach the carburator. One of the following will probably account for this :—

Cause 1.—Petrol supply tap has turned itself off by vibration against tools, &c.

Cause 2.—No pressure to feed petrol.

Cause 3.—Supply pipe, filter or jet in carburator blocked with a piece of waste, asbestos, dirt, or deposit.

Cause 4.—If the tank is nearly empty, and a very steep hill is encountered, the carburator may be too high for the petrol to run into it ; the remedy is to pump air pressure into the tank.

Cause 5.—A union may be disconnected, pipe broken or plug under carburator dropped off, and you have lost all your petrol, or perhaps the tank has simply run dry. Remedy :—leave your friend to sleep on the car, take list of petrol depôts, and make your way to the nearest town ; if you cannot get any proper spirit, bring out some common benzoline of about 700 gravity and take a spare tin of petrol on the car next time.

C. Carburator flooded.—If, on the other hand, there appears to be too much petrol about, and it is running out of the carburator, the float needle is stuck or bent, or the float has punctured and petrol got inside it. In the latter case, take out the float, make a hole large enough to let out the petrol, and carefully solder up air-tight again.

D. If your burners go out when you start the car, as is sometimes the case, it is due to the jerk of the car sending the petrol from the burners back towards the tank. To obviate this, the tap should be opened as little as possible.

E. If the car stops from some mechanical cause, the reason may probably be found in the former section 'Motor will not start,' or in the chapters dealing with Transmission or Ignition. Most probably it will be due to :—

- i. A broken valve.
- ii. Broken or misplaced spring.
- iii. Valve-gear not operating properly.
- iv. Something has lodged on the face of the valve, holding it open. I have known the cottar of an inlet valve and parts of

sparkling plugs sucked under the inlet valve, where they have stuck or gone into the cylinder and even through into the exhaust silencer.

FITS AND STARTS

If a motor nearly stops and then goes on again, it is generally due to temporary starvation of the carburator. There is probably some water, oil, waste, dust, asbestos, dirt, or deposit of some sort at the ingress of the spirit, which, however, sometimes frees itself. To avoid these troubles petrol should never be poured into the tank except through a funnel fitted with a very fine gauze strainer or a piece of muslin. I have known a little particle of matter dance about in the mixing chamber, and once in a way it would lodge on top of the spray-nipple for a time.

It should be remembered that air must always find an inlet to the tank in order that the petrol may flow out freely, and considerable difficulty has been caused by the tiny vent-hole which is drilled in the stopper of the main tank becoming blocked up by some dirt or an overcoat lying on it under the cushion. It may happen that air can get to it when you are starting up; then when you sit down on the cushion the hole becomes air-tight and the engine gradually stops.

MOTOR WILL NOT 'PULL' WELL OR MISSES FIRE

We will treat this malady under the following headings:—

- A. Ignition.
- B. Compression.
- C. Carburation.
- D. Too much oil.
- E. One cylinder will not work at all, and
- F. Irregular missing.

A. Nothing is so annoying as to drive a motor which is continually missing fire or has a 'fit of the slows.' The fault is usually with the ignition—the platinum tubes are not hot

enough, or are dirty inside or outside, or the passages leading to them are clogged. When exhaust pressure is adopted for feeding the burners with petrol, the pressure-valve sometimes refuses to act and lets the pressure out. Remedy for this :— Grind the little valve or change the spring, and see that its lift is just one millimetre. Perhaps there is oil on the sparking plugs, or the battery is run down, or the timing is not correct, but we are here trespassing on to the province of 'Ignition' (see Chapter VIII.). If the root of the difficulty is elsewhere, perhaps

B. The compression is poor (see 'Motor will not Start') or

C. The carburation is not good :—

Cause 1.—The proportions of air and gas are not well adjusted.

Cause 2.—The petrol is stale.

Cause 3.—Petrol cannot get free access to the carburator (see 'Fits and Starts').

Cause 4.—The gauze through which on some cars the air is sucked is blocked with dust, or the gauze which is sometimes fitted into the induction pipe is dirty, or that fitted between the exhaust and the pressure valve (in cases where a branch of the exhaust is utilised to maintain pressure in the petrol or lubricating tanks) is foul.

Cause 5.—A pipe-joint is loose or has a hidden crack through which an excess of air enters.

See also 'Carburation,' pp. 165 and 166.

D. *Too much lubricating oil* is used, causing (i) valves to stick ; (ii) a deposit on the sparking plugs ; and (iii) an unhealthy charge in the cylinder. Excess of oil reveals itself in the form of smoke issuing from the exhaust.

E. One cylinder does not work at all. If one cylinder misses fire *regularly*, it is probable that

- i. The exhaust or induction valve has given up the ghost, or
- ii. The nozzle for supplying that cylinder with spray is blocked.

F. If, however, the miss-firing is *irregular*, and none of the defects aforementioned are found, we must look to less common sources for the difficulty.

How to find which Cylinder Misses.—Endeavour first to ascertain which cylinder is the culprit. One method of doing this is to place your hand on each exhaust pipe while the engine is running. You will then get a bad burn from every one except that belonging to the faulty cylinder. A more convenient way—if electric ignition is fitted—is to stop the working of three out of four of the induction coils, changing about until you find the one that is at fault. It may be, however, that your engine has only one cylinder, or that all the cylinders miss occasionally.

Let us take the various possible causes of the difficulty.

Cause 1.—Be sure that the governing gear is working properly, and that the governor does not cut out one cylinder when it ought not.

Cause 2.—The induction valve may be worn, and opens too much.

Cause 3.—Exhaust-valve lifters worn and do not lift enough.

Cause 4 (rare).—They have expanded through being overheated, and open too much.

Cause 5—A spring displaced.

Cause 6.—The exhaust or induction valve springs are not strong enough to close quickly, and an exhaust valve may sometimes open on the suction stroke.

Cause 7 (rare).—The mushroom-shaped fitting called the diffuser, which is part of the small disc screwed into the top of the carburator, may be too near or too far from the jet of petrol.

Cause 8.—Or the size of the nipple through which the jet is sucked is too large or too small. It is very seldom that this should be touched, and its adjustment must be made with extreme delicacy, by the aid of a watchmaker's brooch-needle. It is always best to make any experiments on a spare nipple, and not to touch the one that is in use, so that if unsuccessful you may put back the old one, otherwise the last state of your carburation may be considerably worse than the first.

Cause 9 (rare).—Freezing of the carburator. Trouble will sometimes arise through the carburator freezing, even in warm weather. The remedy is to fit a pipe to convey to it air heated by the exhaust or the burners.

There are still a few but extremely improbable causes for irregular firing :—

Cause 10 (rare).—There may be too much play worn in the cogs of the valve gear or ignition gear. The remedy is to advance one tooth.

Cause 11 (rare).—The cog wheels of the 'two-to-one' gear may have been put together wrongly by a repairer.

N.B.—Always make your own marks when taking these wheels apart, for the existing marks may not necessarily be correct. The makers often find a better position for the teeth to engage after one set of marks have already been made.

Cause 12 (rare).—It has also happened that the key or feather by which a gear wheel of the ignition or valve mechanism is keyed on to its shaft has sheered, and the wheel has moved round on its spindle, causing firing to take place at the wrong instant, and very erratic behaviour in consequence.

Cause 13.—For reasons previously explained, if water can find its way into the cylinder, misfiring may result.

Finally, remember that if your engine is misfiring or pulling badly, the fault may of its own accord very likely disappear altogether after a little running.

ENGINE RACES, I.E. GOVERNOR WILL NOT WORK

Evidently something wrong with the governing gear. What?

Cause 1.—The cam, which, by means of a small fitting which resembles a hammer, throws the exhaust-valve lifters out of action, is keyed to its shaft by a small screw ; if this works out, as it sometimes does, the cam will move about where it likes, and leads to the fault in question.

Cause 2.—Similarly if the 'hammer' gets loose or is worn, the same result will follow.

These remarks refer to the engines of the Daimler and Panhard type.

Cause 3.—In these motors the governor is usually arranged to cut out one or two cylinders before the rest ; if much wear has taken place in this mechanism the trouble in question may arise.

There are also springs whose function it is to bring back the exhaust lifters into action after they have been 'cut out' by the

governor. If this mechanism has been roughly fitted or has had much wear, I have often found that the ends of these springs should be slipped off their knobs for the engine to govern properly ; and that if they are in place one cylinder may refuse to cut out at all.

Cause 4.—Of course if any of the delicate spindles, &c., connected with the governing mechanism be strained in any way, or are allowed to get dry for want of oil, the same trouble may be expected.

If the governor goes wrong at an awkward moment in the traffic, and the engine begins to race, it may be controlled by switching off and on, or retarding ignition, admitting an excess of air, or the exhaust-valve lifters may be thrown out by hand.

UNUSUAL NOISES

Regular.—If an unusual but regular *puffing* noise (external) is heard, which keeps time with the engine without apparently affecting its running, it is clear that an exhaust joint has given out somewhere between the exhaust valve and silencer. If the rupture is near the engine, the exhaust gases may slightly interfere with the burners and the mixture, but otherwise no harm will be done to the motor, though the noise may frighten passing horses considerably.

A regular but unusual *tapping* coming from the engine indicates

- i. Something loose or broken.
- ii. Too much advance in ignition, or
- iii. Engine about to seize through overheating.

If a *squeak* is heard anywhere instant attention should be paid to it, otherwise much harm may be done. A slight squeak is often very difficult to locate, and turns out sometimes to be perfectly harmless ; a squeak has been traced to the rubbing of the bonnet against something inside it, to the shaking of the radiator, vibration of lamps, and such like causes, which, though trivial when found, are sources of great anxiety to a careful motorist.

I have had a distinct whistling sound produced by the rapid suction of air through a brass tap at each revolution of

the engine. This took a long time to discover. A slight leak of compression will also sometimes produce a squeak at each explosion.

Irregular.—Popping Noises in the Carburator or Induction Pipes.—These are minute and harmless explosions caused by :—

- i. Induction valves opening too much, or
- ii. Sticking, or
- iii. Their springs being too weak.
- iv. Cold ignition tubes.
- v. Retarding the ignition suddenly at high speeds, or
- vi. Bad carburation.

Bursting Noises (irregular) coming from the Engine.

i. These indicate :—Burst joint at valve cover, sparking plug, or ignition tube. Spare washers specially made must always be carried to rectify these.

ii. A platinum tube may have burst. Spare ones should always be carried.

What to do if Ignition Tube bursts and you have no spare one.—If you have no spare one, the hole of the old one should be closed up as much as possible with a small hammer, then replace the tube with the hole in such a position as not to blow out the burner or its neighbour. If you can keep the burners alight progress can thus be made. Failing this, the faulty tube or the hole leading to it must be blocked up, and the car run home on the remaining cylinder or cylinders.

iii. *Loud Report in Exhaust.*—This is due to several unexploded charges having collected in the silencer, and being ignited by the incandescent products of the next fired charge; switching the electric ignition off and on will often produce this, so may a sudden retarding of ignition, or a semi-cold platinum tube.

There is no danger in these explosions—startling as they seem—beyond the risk of splitting the exhaust box or pipe.

RÉSUMÉ

It will now be seen that troubles may arise from any of the six following sources:—

Ignition	Lubrication
Carburation	Circulation, and
Compression	Moving parts

I have tried to classify all possible troubles according to their symptoms, so as to make it easy for the novice quickly to locate the root of evil and rectify the fault.

CONCLUDING ADVICE AND REMARKS

If your motor works well, leave it alone, although it may never seem fast enough. Many troubles arise from interference and undue curiosity.

Remember that petrol is a highly volatile and inflammable liquid ; its vapour is equally dangerous.

Make sure that all petrol connections and unions are taut.

If you have a flare-up, immediately close the supply cocks or let off the pressure, take off bonnet to save the paint, and smother the flames, or let them burn out. Water should only be thrown to save woodwork.

Do not pour petrol near a naked light ; it is prudent to extinguish the burners when filling the tanks of the car.

Do not spill the petrol over your clothes and then strike a match to light your pipe.

Do not go out even for a short run without complete equipment of tools, spare parts, petrol, and repair outfit, or you may be back late.

Do not let a willing ostler fill up your petrol tank with water.

Do not leave the water in your car on a frosty night, except with 20 per cent. of glycerine in it.

Do not start away with your brake hard on and wonder why the motor is not pulling.

Do not pedal your tricycle for half an hour before remembering the plug switch, unless the doctor recommends it.

Do not let the starting handle fly off and hit you on the chin, and

Do not trouble to turn on the petrol tap if there is none in the tank.

CHAPTER X

THE PETROL CAR

I. TRANSMISSION

BY HENRY STURMEY

THIS is a wide subject, and to be properly and thoroughly dealt with requires much more space than has been placed at my disposal, so that I shall simply endeavour to deal broadly with the principles of the best known types. Next to the engine itself the construction of the transmission gear is the most important thing about an autocar; for as this portion of the machine is the medium through which the power is conveyed from the engine to the wheels, it does not require an intimate knowledge of mechanics to perceive that bad design and undue friction here may make a very material difference in the running and speed of the car. As a matter of fact the whole power of the engine is never available for the work of turning the wheels of the car, a certain portion of it always being absorbed in the work of driving the gear; indeed, it is not too much to say that in some instances—as has indeed been proved by actual tests—fully one half of the power developed by the engine is thus lost between the motor and the wheels. Consequently high efficiency in the transmission arrangements will mean greater economy in work, as well as better hill-climbing and speed results from the same engine, than would have been the case had a more faulty system been adopted. Broadly speaking, it may be said that the old adage ‘simplicity is a virtue’ holds particularly good in this connection, and it may be taken as an axiom that—all other things being

equal—the simpler the gear the better and more efficient will it be.

That being so, it may not unnaturally be asked why the simplest method is not always used. If it were only the matter of conveyance of the power from the motor to the road wheels, doubtless this would be done ; but where the petrol or internal combustion motor is used another matter has to be provided for, and that is the variation of the ratio of engine speed to wheel speed ; for with the great majority of motors of this type, unless the speed rate of the motor can be maintained, it will stop, so that 'variable gearing' has to be adopted and the power sent through this to the wheels. By this I mean that the means of transmission may be so altered at will that whereas when on level ground the engine may make, say, only two revolutions to each one of the road wheels, for hilly or heavy work it may make, say, four, six, or eight, and so, whilst the car travels slower, the engine speed may remain the same. Where steam engines are used this is not usually required, as the steam engine obtains more power for heavier work by the use of more steam.

Now the simplest method possible would be the driving of the road wheels or wheel direct by the piston-rods of the engine, a plan only possible where a very small wheel is used, and only actually employed in the Holden bicycle as described in the chapter devoted to this type of machine. Next to this comes the use of gear wheels—'cog' wheels—as employed upon tricycles and some light forms of car where the motor is set close to the axle. In these we have one gear wheel fixed to the shaft of the motor, gearing into a similar one upon the axle. And here we may halt for a moment to consider the action of gear wheels. As will be seen by fig. 1, we have two wheels, the edges of which are cut into a number of equal-sized teeth, and these wheels are so fixed in relation to each other that the two sets of teeth mesh or interlock with each other. Now it will be seen that any movement of one will be imparted to the other through the teeth, but *in an opposite*

direction—thus if wheel A revolves to the right, wheel B will turn to the left, and *vice versa*. There is also another peculiarity about these wheels. It will be noticed that they are of different sizes. The result is that if wheel A is the first to receive the power, one turn of the wheel will not cause wheel B to make a complete turn, whilst, conversely, wheel B being the larger of the two, will, if revolved, cause wheel A to turn more than once. Just what their actual relation of movement to each other may be, is determined actually by their respective diameters and, for ease of calculation, by the number of teeth they respectively contain. Thus if wheel A contains 20 teeth and wheel B 50, it will take $2\frac{1}{2}$ turns of A to revolve B once,

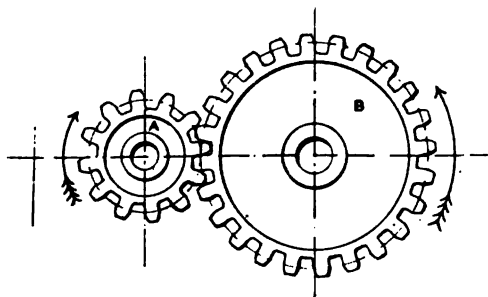


Fig. 1

whilst one revolution of B as the driver would cause A to go round $2\frac{1}{2}$ times. It will thus be seen that by varying the size of the different gear wheels used, the ratio between engine and road wheels can be varied. In an arrangement employing this simple form of transmission only, the engine and axle must be set close together, and we only have the friction in the bearings of the engine and road wheels to be overcome, together with that caused by the teeth of the gear wheels as they engage with and push each other around. When, however, it is found desirable that the engine should be separated from the road wheels, some other form of transmission becomes necessary, and other means have to be adopted; and the simplest and

cheapest in point of manufacture, though not the most efficient, is shown in fig. 2, where we have, as before, two different-sized wheels, one connected with the motor-shaft and the other with the driving-axle of the road wheels. Instead, however, of their faces or edges being cut into teeth, they are smooth, and the two are connected by a flat leather belt. Here, as before, the wheels will be revolved in relation to each other according to their respective diameters, but, as shown by the arrows, they will both revolve the same way. This is advantageous, for every time the direction of power application is changed some loss takes place. By crossing the belt, however, the pulleys or belt wheels may, if desired, be made to revolve in opposite directions. On the other hand, the

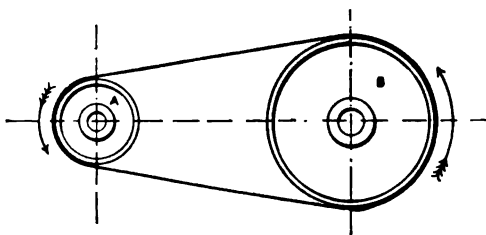


Fig. 2

connection, not being positive, but depending upon the tightness or grip of the belt, there is more or less slip, so that the ratio of rotation is not constantly the same, and as, in order to obtain sufficient grip for heavy work, the belt has to be tightly stretched, the two wheels at either end are forcibly pulled towards each other, and some extra friction, through pressure, produced in the bearings. The slip of the belt, however, is not altogether a disadvantage, as it absorbs the shock of the engine and prevents damage from that cause, whilst there being no metallic parts in contact, belt driving is quite silent in running, and this cannot be said of gearing, much of which is very noisy, which is not only an annoyance but an eventual source of trouble, as noise means wear.

Another form of transmission may be said to combine the principal features of both the previous systems, and that is chain driving. Here, as before (see fig. 3), we have two wheels or pulleys connected by a flexible band, but the pulleys are not smooth as before. Their faces are cut into teeth suitably shaped to engage the links of a metallic chain which takes the place of the belt. As with belt driving the driven pulley or chain wheel, *B*, revolves in the same direction as the driving pulley or sprocket *A*. This method possesses the feature of positive driving belonging to the gear wheels, and whilst it has none of the slip of the belt there is some elasticity in the chain, which helps to take up driving

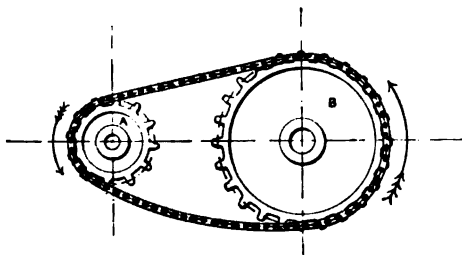


Fig. 3

shocks and secures silent running. The extra friction on the bearings necessitated by belt driving is avoided, as the chain may be run fairly slack and the lower side hang loosely as shown in the diagram, the chain automatically tightening itself at the top as the different links are taken up by the teeth in the drive.

Where two chains are used there is frequently some rattle, owing to the two not being able to run exactly together, but a single chain is—like that of a bicycle, which it much resembles—practically silent. Wet, mud, and dust will also cause chains to ‘grind’ and become noisy, and therefore in order to obtain the best results they should be enclosed in a cover or gear-case, which will protect them from these enemies; and the

same may be said of both gearing and belts, for both are better servants in every way if so protected. The chains used are similar in construction to those fitted upon bicycles, and are either of the 'block' or 'roller' variety. In the former (see fig. 4) the side links, *c, c, c*, are connected by solid blocks of

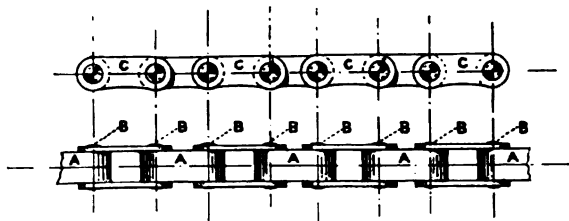


Fig. 4

metal, *A, A, A*, through the ends of which the connecting pins, *B, B, B*, pass, these pins turning slightly in their bearings in the blocks as they pass round the chain wheels. In the latter—shown in fig. 5—the blocks are replaced by connecting plates *A, A, A*, and upon the cylindrical separators connecting them

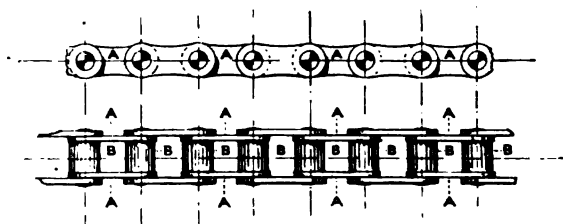
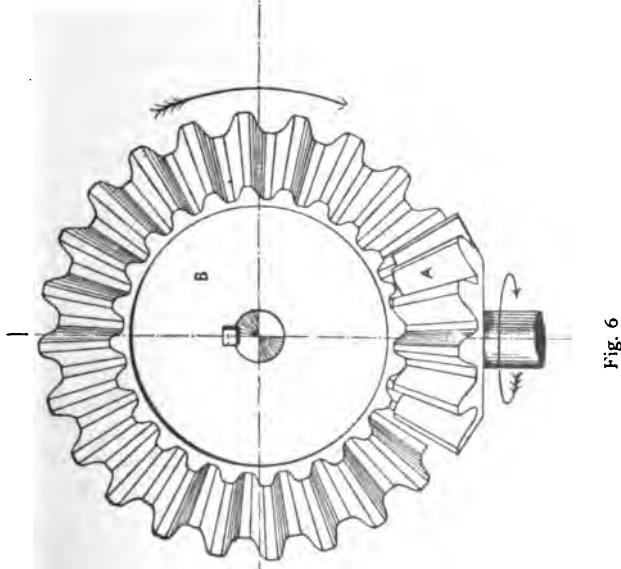
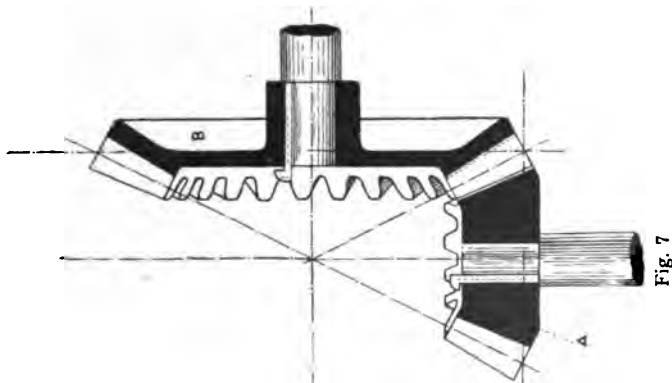


Fig. 5

small cylinders or rollers, *B, B, B*, are fitted, which roll into and out of the chain-wheel teeth as they come round. As a rule, unless some special provision is made for thorough lubrication of the connecting pins of the blocks, roller chains are usually found to run with the greater smoothness and quietude. In addition to these methods we have yet another which has been

very largely used lately, especially upon light cars, and that is the use of bevel gearing and a connecting-rod, with universal joint to secure flexibility. This system is shown in figs. 6, 7,



8, and 9. Here we have a rod or shaft with a gear wheel at

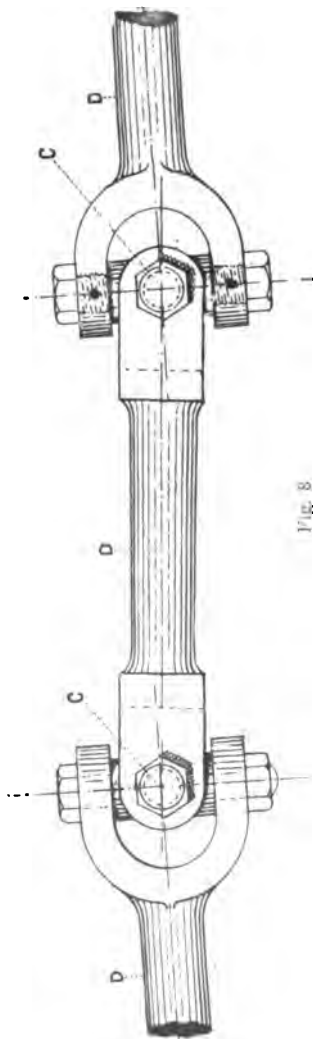


Fig. 8

one end. This wheel, however, is conical or bevelled (see A, figs. 6 and 7), and the teeth are wider on the outside than upon the inside. It engages with a wheel B upon the axle or other portion of the machinery, which is also bevelled, and bears corresponding teeth. It will be seen that whereas in each of the three methods first described the axes of the motor shaft and wheel axle are parallel, in this case they are at right angles, the forward end of the shaft being united to the motor shaft by a clutch or other suitable means, and rotated by it. In action these bevelled wheels are similar to the gear wheels first described, but instead of revolving lightly on their bearings and pushing round the teeth of the opposite wheel as they come in contact, their shape causes a strong repelling action also to take place, the tendency of the bevelled faces of the gear wheels being to force themselves apart, which throws a considerable cross

strain upon the bearings. The power, too, is deflected at right angles, which is another source of loss.

In order to permit of the free vertical movement of the wheels under the springs, two universal or 'Cardan' joints, c, c, are fitted within the length of the shaft D (see fig. 8). These consist of two jaws set at right angles, with their ends connected to and rocking upon the extremities of a right-angled connecting piece. This allows movement in all directions, and the shaft accommodates itself to the conditions of the drive. This method is chiefly used because of convenience and some neatness.

Another plan, employed however only by one or two firms, substitutes for the bevel gearing what is known as skew or screw gearing, a very smooth and silent drive without the spreading or bursting action of the bevels, the end of the driving shaft being fitted with a screw which drives a series of teeth cut diagonally around the circumference of the driven wheel.

I have said above that the forward end of the arbor shaft is connected to the engine shaft by a clutch, and this brings me to another almost universal and very important portion of the transmission gear. In belt-driven cars a clutch is rarely used, the slip of the belt being relied on to give the necessary immunity from shock, but in cars which are driven by chains, arbor shaft, or gearing, a clutch is a necessity, otherwise the sudden application of power would strip the teeth of the gear, break the chain, or cause other damage, and something is needed to ease the shock. Clutches may be 'positive' or frictional, but friction clutches only are referred to above. These commonly take the form of a truncated cone or inclined surface so arranged upon that portion of the transmission which carries the gearing or other connection with the wheels that, by sliding it slightly forward, it enters a socket having an internally coned surface into which it exactly fits. Sometimes one of the surfaces is covered with leather, but otherwise both are metallic, and a strong spring is usually

fitted at the back of the cone by which it is forced into its socket. In a great many of the most popular types of car the hollowed socket for the cone is formed in the centre of the fly-wheel of the engine, which thus drives the mechanism through the clutch. The spring has a certain tension, and the friction between the two surfaces when pressed together by the spring is sufficient to drive the car without slip under all ordinary circumstances ; but at starting, when the power is applied suddenly to an inert mass, a much greater amount of friction is engendered, and the cone slips slightly in

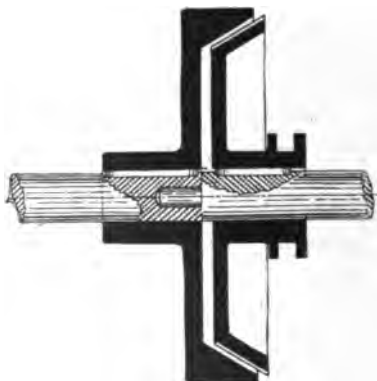


Fig. 9

its socket, thus saving the gearing and the machinery from jar and shock, and enabling the power to be applied gently. The construction of a clutch of this character is shown at fig. 9.

Occasionally also two friction clutches acting in opposite directions are used to connect or disconnect alternately some portion of the gear, in which case they are not spring held, but are moved from side to side by a lever—thus, in fig. 10 we have two gear wheels, which may be of different sizes, running on one shaft with a double clutch between them. By moving the clutch over to the left, wheel A is held fast to and driven by the shaft upon which the clutch slides, whilst by moving it

in the opposite direction, wheel A is freed, and wheel B held fast, and if the clutch be held stationary at a point midway between the two, both wheels are free and neither is driven. In another form of clutch, connection is made by expanding friction rings on the inner faces of drums, fixed to the parts to be driven. Positive clutches are used temporarily to connect various portions of the gear from time to time, as may be required, and these take the form of notches or projections upon a sliding ring or collar or other part of the machinery which, when moved along a shaft, can engage with or slip into

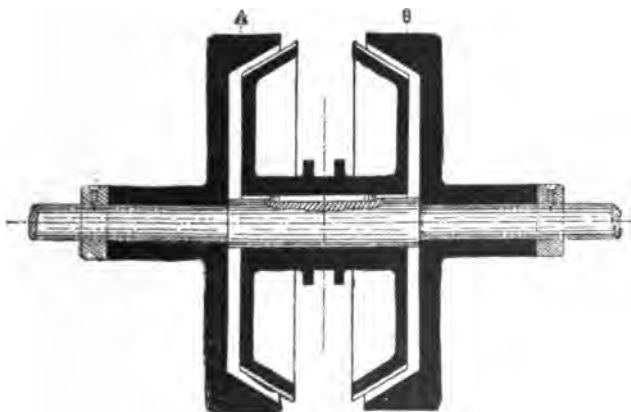


Fig. 10

corresponding notches or projections on the part with which it is desired to make connection. In this case the connection is sudden, and from a position of absolute rest the part put into gear by the clutch is instantly moved forward at the same velocity as the rest of the machinery the moment the clutch teeth slip into their places. Figs. 11, 12, and 13 show a common form of positive clutch. This form of clutch, it may be noted, is—or should be—always used in conjunction with a clutch of the friction order—i.e. whilst individual portions of gear may be connected with and disconnected

from each other by the use of positive clutches, a friction clutch always connects the engine with the machinery so that the shock is taken up there. The teeth, notches, or projections of positive clutches require to be very carefully and accurately cut and properly hardened, for if they are not they are very apt to be chipped and to wear by the action of engagement.

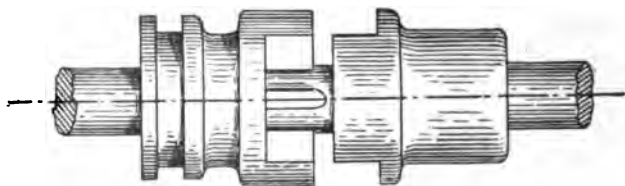


Fig. 11

Rough edges denote chipping, and rounded edges much out of shape indicate wear. When this is the case the gear becomes very noisy in action, and much movement of the parts is noticeable when the actuating lever is moved to and fro. In these circumstances they will require facing or re-cutting, and this should be done at once when such a condition of things is discovered,

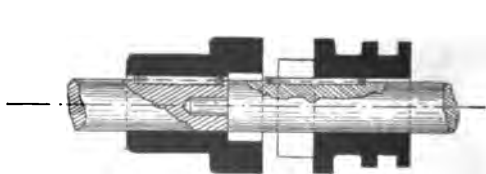


Fig. 12.—Section

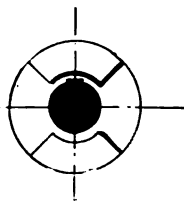


Fig. 13.—End Section

or the condition of the parts will rapidly go from bad to worse. These latter remarks also apply to the teeth of gear wheels.

Having now briefly considered the principal details of simple transmission, we pass on to the means whereby the ratio of the gears may be altered as required by the road conditions, and in so doing have to combine the speed-varying

gear with the transmission gear proper; and the best way to do this perhaps will be to illustrate the principles employed by reference to examples of the various systems.

In the first place, belt-driving cars have usually two belts running on pulleys of different sizes, so that shifting the belts causes either one or the other of the two speed ratios to be used. The belt system generally drives the car through chains, so that whilst belt gearing is used for the speed variation, the transmission to the wheels is by chains.

In using belts care must be taken in shifting the belts to throw off one before attempting to put the other into operation, or broken belts and perhaps worse accidents may result. Belt driving is wonderfully smooth and quiet in action, and commendable from this point, but unless very carefully looked after liable to give trouble by undue slipping and breaking. When carefully attended to and intelligently applied, belts can be made very satisfactory. Mr. Lyons Sampson, for instance, tells me he has had one pair of belts in use for over a year, and has had no trouble with them. But then Mr. Sampson has given the subject very careful consideration, and sees that they get the little care they need. For instance, he runs his belts flat instead of crossed, which by not bending them so much puts less strain on the fibres. He uses the belt, too, with the skin side to the pulleys, protects them as much as possible from wet, and uses loose pulleys of the same diameter as the fast ones instead of slightly smaller, as is usual. This, whilst keeping the strain on during use, does not necessitate the belt being pushed up over the sharp edge of the fast pulley every time it is put into action. Mr. Sampson is also careful to take the belts off entirely when the car is not in use, and so relieve them of strain.

Mr. R. W. Buttemer, another successful belt-user, recommends using lightly tanned leather for the belts instead of raw hide, which is preferred by some, and before putting on a new belt hangs a 1-cwt. weight on it for a day or two to take the stretch out of it, following this by a soaking in castor oil,

which oil is also occasionally applied during use. The wider and longer the belt, the larger the pulleys, and the faster their speed of rotation the better will the results be, so that narrow or short belts and small pulleys in positions of no great speed should be avoided. If a belt slips unduly its under surface may be treated with Sternoline belt dressing, which very much increases the grip, and Mr. Buttemer has a good word to say for Collan oil for this purpose; but if this is not effective, it is evident the belt has stretched, and it must be taken off, half an inch or more, as required, cut off one end, and the two ends joined up again with a belt fastener, which consists of a small malleable iron casting carrying rows of teeth which are driven into the belt with a hammer. Failure of these to hold is generally due to their having been flattened out by hammering. In joining up a belt see that it is cut square across and the two parts joined in accurate alignment. The belt may also be joined by lacing the two ends together with a strong leather lace, a method which Mr. Buttemer advocates when using new unstretched belts, as then the stretch may be taken up by tightening the lacing without taking off the belt again. 'The secret of success with belt driving,' writes that gentleman, 'is to have belts as large as admissible, of sufficient substance and good leather, protected from wet and mud and well dressed with castor or Collan oil, and under these conditions they should never give trouble beyond the occasional taking up of slack.'

The usual arrangement provides two speeds only, and to get a third speed for surmounting excessive gradients the loose pulley of the lower gear is furnished with what is termed a 'Crypto' gear—which, however, is not a true Crypto, but what is known as a lathe back-gear action, fitted to a revolving drum, the holding of which by a brake tightened around its surface and put into operation by a handle causes the gear to come into action, and so effect a still further reduction of speed.

But although the Benz gear is not a true 'Crypto,' as such gears are used upon several machines a few words about the peculiarities of this class of variable gearing may not be amiss.

A Crypto or epicyclic gear is arranged as shown in fig. 14, and consists of two gear wheels, a small one A, with external teeth, and a large one B arranged on the outside of it with internal teeth, whilst in the space between the two one or more pinions or smaller gear wheels, c, c, just large enough to fill the space and cut with teeth to correspond with those on the two gear wheels, are placed, these pinions being mounted on pins carried by a ring or disc D, which may or may not be supported by arms, E, E, E, E, from a centre as shown. We thus have three members, the outside gear wheel, the inside gear wheel, and the pinions, and the whole makes a most accommodating arrangement ; for

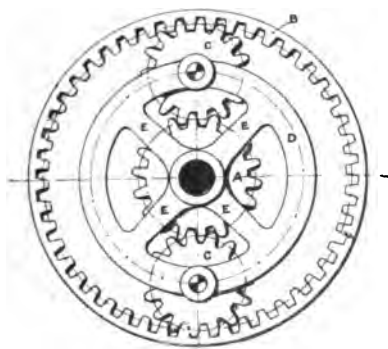


Fig. 14

if the inner wheel A be held fast and the ring D, carrying the pinions, revolved, the outer wheel B is caused to revolve at a faster rate than the ring, whilst if the outer wheel is held the inner wheel will also be driven at a faster speed, but in different ratios. On the other hand, if either the outer or inner wheel be held and the other driven, the ring or disc D, carrying the pinions, will be caused to revolve at two several lower rates of rotation ; whilst if, in its turn, the pinion-ring is held and either of the wheels driven, the other wheel will be rotated at a different rate of speed, but in *the opposite direction*, and so a reversing action obtained, and by locking any two members

together the whole contrivance is held rigid and revolves as a solid wheel. By connecting any one member of a gear of this character with the engine shafting, and another with the wheels, and locking the third to the frame of the car, a great variety of adaptations can be made to meet special needs, this arrangement having the advantage of neatness and compactness, and having all the gear wheels in constant engagement with each other all the time.

A gear of this character is used upon the Duryea, which has probably the simplest transmission system of any, and is quoted as the most striking example of direct chain transmission. In this the Crypto is carried on the engine-shaft, and for ordinary use the inner and outer members are locked together by a friction clutch and catch bolts, the whole revolving solid, whilst a self-lubricating silent block chain carries the power from a sprocket on the gear direct to the differential on the axle of the driving wheels; thus under all ordinary running conditions there is only the friction of the direct chain drive from engine to wheels. All intermediate speeds are obtained by varying the speed rate of the engine, which in this case possesses great flexibility and power, and will take the car up a 1 in 8 grade without change of gear. When steeper gradients than this have to be tackled a brake holds the outer wheel of the Crypto, which is driven by the inner wheel and a 75 per cent. speed reduction of the sprocket—in connection with the pinion-ring—obtained, whilst for reversing a band brake is in turn applied to the pinion-ring, which is thus held to the frame and the action reversed. The general arrangement of the gear on this car is shown in fig. 15, where A represents the engine, B the fly-wheel, C the Crypto tucked inside it, D the steering-handle, working, by means of the lever E, the clutches F, F'. G is the outer bearing of the gearing, H the driving sprocket, I the chain, and J the differential on the driving axle. The gear changes are made by raising or depressing the handle grip on the steering lever D, and the reverse brake applied by the depression of a lever by the heel.

The large majority of cars to-day, especially those of the heavier and more expensive class—such as Daimlers, Napiers, Panhards, &c.—are fitted with wheel-gearing and chain transmission, and in these, although the constructional details may vary with different makers, the principles and general system are the

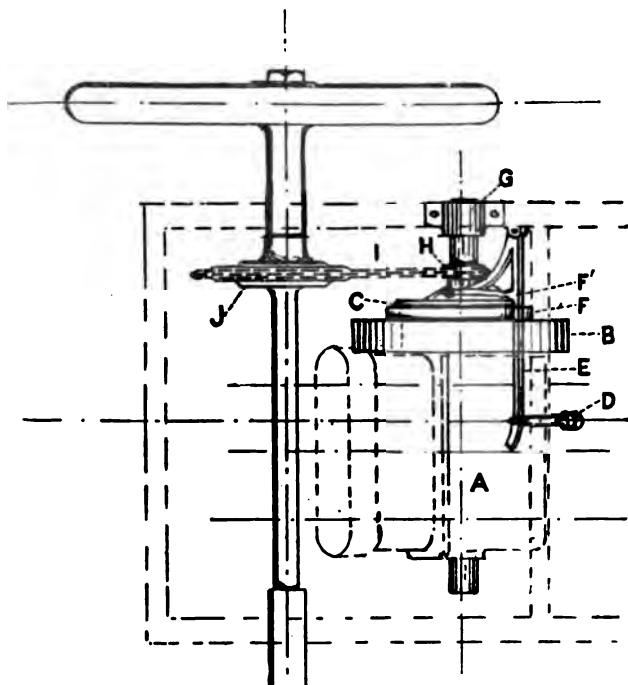


Fig. 15.—Duryea Transmission Gear

same. In the illustrations figs. 16 and 17 I have taken the transmission system of the 12 h.-p. Daimler to illustrate the type. This arrangement gives three speeds and a reverse. Others are more frequently arranged to give four speeds, but the system is the same. Fig. 16 shows the arrangement looking down from the top and fig. 17 is a sectional drawing of the gear

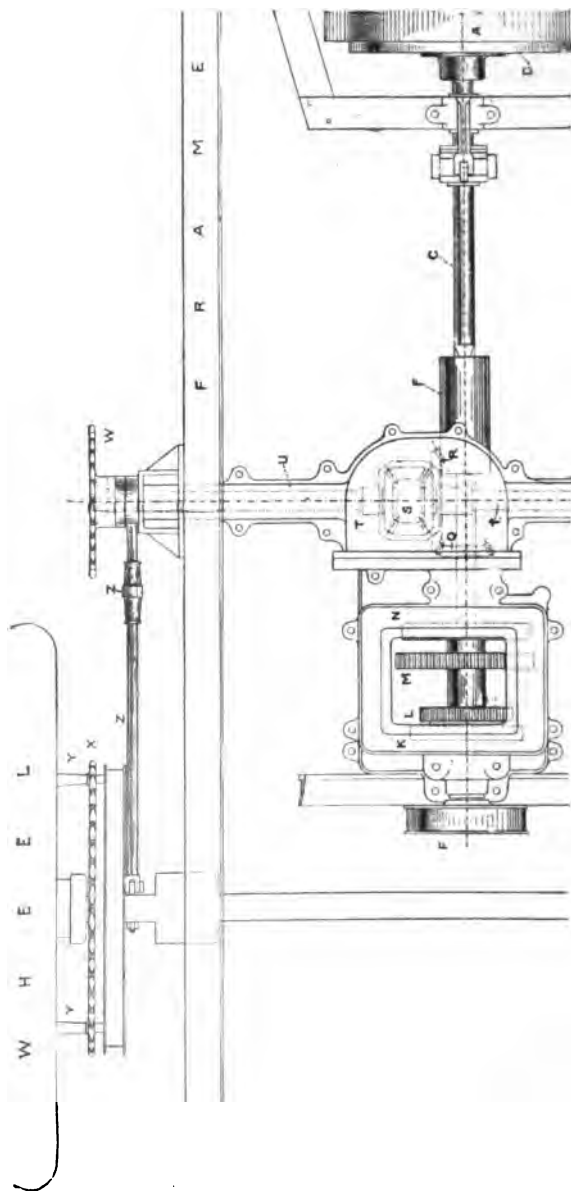


Fig. 16.—Daimler Co.'s Transmission Gear. Plan

looked at sideways. Here A represents the fly-wheel of the motor, and B the clutch working into its face. The clutch drives the shaft C, and can be drawn back and so disconnected from the engine by pressure on a foot lever coupled up to the end of the lever D shown in fig. 17, the end of this lever also being attached to a strong adjustable spiral spring (not shown) which keeps the clutch engaged on the fly-wheel, allowance for this drawing back being made as shown at E, the shaft being in two pieces, the ends connected by the slide-block F. The driving-shaft runs back down the centre of the car, and carries a series of three different-sized gear wheels, G, H, and I, so arranged that whilst they are carried round with the shaft, they are free to slide to and fro upon it

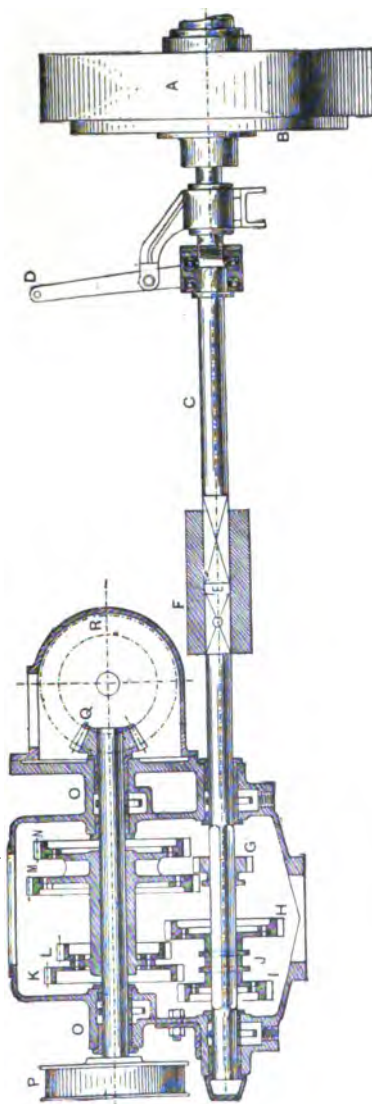


Fig. 17. — Daimler Transmission Gear. Sectional elevation

when moved by a hand lever at the side of the car, which is connected up with the slide collar *j* (fig. 17). Thus all three gear wheels revolve at the same speed as the engine. Immediately above this shaft, as shown in fig. 17, is a second shaft arranged parallel to it. This carries upon it the four gear wheels *k*, *l*, *m*, and *n*, all of which are fixed to it and revolve with, but do not slide upon it. This second shaft and its attached gear wheels are contained in the same metal gear-case in which the other gear wheels are enclosed, and which can be filled with lubricating oil. It runs in bearings *o*, *o*, in the walls of the case, through which it projects at either end. The rear end carries a drum *p*, around which a band brake is applied, and the forward end carries a bevelled pinion *q*, which gears with and drives a bevel wheel *r*.

This wheel is attached to the differential or 'balance gear' *s* (fig. 16) connecting the two halves of a cross countershaft *t*, which runs in long bearings *u*, forming a cross support to the frame. The ends of the cross shaft are furnished with chain sprockets *w*, each carrying a chain which connects with and drives one of the driving wheels through the medium of a chain wheel *x*, which is bolted to the spokes by the bolts *v*. Any stretch in the chains may be taken up by turning the nuts *z* on the radius rods *z z*, the purpose of which is to maintain and adjust the proper distance between the countershaft and the wheel axles, and so secure the proper tension on the chains. In making this adjustment, care should be taken to see that the two rods are adjusted equally, or the chain wheels and sprockets will be thrown out of line and the chains may come off or break, besides putting much strain on the bearings and causing considerable additional friction. By putting on different-sized sprockets on the ends of the countershaft the ratio between the revolutions of engine and road wheels, so far as the top speed is concerned, may be varied to suit requirements, and by shifting the gear wheels, *g*, *h*, and *i*, so that they engage with either *k*, *l*, or *m*, this speed may be maintained or reductions made from it. Thus it will be seen that the different-sized

gear wheels are arranged on their respective shafts at such intervals that when one pair are in gear, the others are out of gear.

In the gear as shown, H, the largest wheel on the driving shaft is arranged to engage with L, the smallest on the driven shaft, the speed of which is, when these two wheels are in gear, increased; I, next in size on the lower shaft, gears with K, which is larger in diameter than I, so that when these two are engaged, the speed of the top shaft is less than that of the bottom one. Again, when G, the smallest of the three on the driving shaft, is in gear with M, the largest on the driven one, the speed of the latter is still further reduced. By moving this wheel G to the left it just clears wheel N on the upper shaft, and by further movement in this direction is brought into engagement with a third or intermediate wheel, not shown in the drawing, which is in engagement with N, and this, by conveying the power through the three wheels, causes N to revolve in the opposite direction to that taken by the other wheels on the top shaft, and thus a reversing action is obtained, and the driving wheels are impelled backwards instead of forwards. This shifting of the gear is effected by sliding the bottom series of gears in either direction as required, bringing the teeth of the two sets of wheels in juxtaposition and pressing the one against the other, till they slide into each other. This is an operation requiring considerable care, as both sets of wheels are revolving at a high rate of speed, one propelled by the motor and the other by the travelling car, and if they were forcibly brought together the teeth would be chipped or even broken off bodily, so that in making the change great care is necessary. The lever must be moved gently, whilst at the same time the foot must be pressed on the lever of the clutch, which is thus disconnected from the motor and the power of propulsion thus removed from the driving shaft whilst the change is being made. When putting a lower gear into operation, as is necessary when climbing a hill, the speed of the car should be allowed to fall to as nearly as possible the calculated speed of

the reduced gearing before making the change. Thus, if the calculated speed of the second gear is, say, eighteen miles per hour, the driver should wait until the work of surmounting the gradient has caused the engine to slow the pace down to that, and not try to make the change when the car is still doing twenty. Some little practice and intelligent observation is necessary before this can be nicely done, but that sort of thing is where much of the charm of driving a good car comes in.

Great care should be taken to see that both gear and bearings are kept properly lubricated, or worn surfaces will result, with much extra friction to be overcome, and if not quickly attended to other things may happen of a serious character. The driver should never allow any unusual sound emanating from the neighbourhood of the transmission gear to pass without investigation, for noise means wear—or something worse; thus Mr. Claude Johnson was on one occasion driving when he noticed a knocking or clanking sound apparently proceeding from his gear-box, which upon investigation proved to be a broken pin in the differential. He at once stopped for repairs. Had he gone on, the whole gear might have got adrift and been destroyed, necessitating a costly repair and many days' loss of time.

In fig. 18 we have an example of a shaft transmission car, the type shown being the Renault, which I take not only because it was the pioneer of shaft transmission, but because the speed gearing is entirely different from anything else, and thus enables me to show a unique variation of wheel gearing. In the majority of cars which use the shaft form of transmission the variable gearing is identical in principle with that last described. In our illustration A represents the motor, B the fly-wheel with contained clutch C, and D the gear-box. At opposite ends of the centre of this are two bearings, E, E, in which two shafts, F, F, are carried, these shafts being connected in the centre by the serrated clutch G. The rearmost shaft carries a brake-drum H, within which it is attached to the universal joint I of the shaft J, the other end of the shaft carrying the second Cardan joint K and a bevel pinion enclosed

in the case L, and engaging with a bevel wheel surrounding the differential, which is enclosed in the case M upon the back axle.

In ordinary driving the power is conveyed from the motor direct through the shaft to the bevel gearing, which is a good point. To obtain the second of the three speeds provided, a

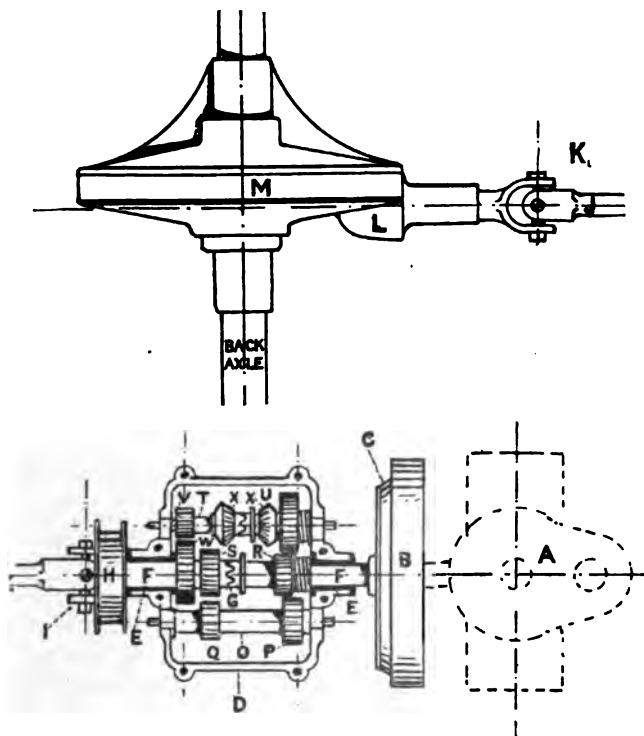


Fig. 18.—Renault Transmission Gear

lever worked by the hand is so actuated that the two shafts are separated by forcing the serrated clutch C apart, and at the same time causing the secondary shaft O, which is pivoted eccentrically in its bearings, to be rotated, so as to bring the two gear wheels P and Q, which it carries, into contact and gear

with the two gear wheels *R* and *S*, which are carried upon the two halves of the divided shaft *F F*. The wheel *R*, which is fast on the shaft driven by the motor, now drives wheel *P*, which is in one with wheel *Q*, and rotates with it, and wheel *Q*, in its turn, drives wheel *S* and through it the transmission shaft and road wheels. Now it will be seen that *R* is slightly smaller in diameter than *P*, and *Q* than *S*, so that the speed of the road wheels is reduced in relation to the motor in the proportion of these differences. The third speed is obtained in a similar manner, but by swinging the other secondary shaft *T* in its bearings and bringing wheels *U* and *V* in gear with wheels *R* and *W* on the main shaft. As the differences in diameter between these four wheels is greater than with the other four, it will be seen that the speed reduction is proportionately greater. Upon the centre of shaft *T* will be seen a serrated clutch and two bevel pinions, *x, x*. This is the reversing gear, which is put into operation by separating the serrated ends of the shaft and dropping a third bevel wheel—not shown in the illustration—into gear with the other two, which reverses the movement between the two halves of the shaft, and consequently drives the main shaft in the opposite direction to that in which the engine is running. With this gear an even greater amount of care is necessary in changing gear than with the last mentioned, as the teeth of the different gear wheels are not slid sideways into each other, but the two rapidly moving toothed surfaces brought up against one another. In all these gear-driven devices the greatest care must be taken to see that full lubrication is provided. The gear-case should be kept sufficiently full of lubricant to enable the lower edges of the gear wheels to be constantly passing through it. It is important, too, that the bearings of the shafts should not be allowed to get too much worn before renewal. All bearings will wear and will require rebushing, i.e. relining with new metal surfaces, and this should be done when any very perceptible shake or side play is detected in them. This condition of things will generally make itself known by increased noise from the gear, and the extent of the wear can be ascer-

tained by taking hold of the shafts and trying what amount of movement both sideways and 'up-and-down' can be felt. The rebushing of the bearings is a matter for an engineer's shop, and not for the amateur's attention. What the latter has to remember is that 'a stitch in time saves nine,' and that neglect of perceptible wear savours of the 'penny wise and pound foolish' policy.

In the above I have but lightly touched on a question the importance of which is second to none in connection with car construction, and I trust I have not only made clear some of the principles employed, but the strong necessity of giving constant care and attention to this very important part if best results are to be attained.

II. FRAMES, SUSPENSION AXLES, WHEELS, STEERING GEAR, AND BRAKES

BY W. WORBY BEAUMONT, M.INST.C.E.

The parts of a car enumerated above are those which are least likely to be detrimentally affected by the want of knowledge on the part of the beginner. Most of them require little or no adjustment, and for the proper fulfilment of their functions the owner can but rely upon the skill of the designer and the honesty of the maker. Their proportions and relations are settled before the owner has anything to do with the car. Upon them, however, depends entirely the safety of the occupant of the car. The motor or engine, the gearing, the carburetter, the electric ignition connections, all may break or cease to play their parts, and the only result will be that the car ceases to be a locomotive. The worst possible accidents are, on the other hand, probable and almost certain if either axles, wheels, or steering gear break, or if pins or nuts are lost from either of them or from the brake gear.

Frames.—Frames are made of so many designs that no general instructions can be given regarding them, and whether

they are sufficient in strength and trustworthiness depends very much upon the method of connecting the running gear and spring suspenders or hangers to them.

Many cars have a main frame to which the spring hangers and other parts are attached, and a secondary frame to which the motor and gear-box, &c., are attached. This secondary frame may be, and generally is, so connected, as in the Panhard and the Daimler cars, that the main frame is relieved of the local stresses which result from direct but separate connection of the motor and gear to different parts of the main frame.

The motor and the main clutch shaft must be truly in line, but if these two main parts of the mechanism are separately attached to a weak frame, the frame twists and bends sufficiently to cause trouble with the clutch, because the one part of the clutch is not parallel with the other, and the inner cone only presses locally in the outer cone instead of fitting all round. Clutches used much when this is the case slip most when slipping is least wanted, soon cause much trouble, and only complete refitting and renewal of the cone surface can secure perfect action.

Most frames are made cycle fashion—of round tubes brazed together and with many of the ears and brackets for attachment of other parts brazed on. When the tubes are good and of ample dimensions these frames are good, but harm may so easily be done to the steel tubes by injudicious brazing that it is well to watch the frames carefully at all joints and connections, so that any flaw or any loosened lug may be discovered. When spring hangers or brackets are attached to these frames so that they splay outward or out of the direct line of pressure from bracket to frame, they put a torsional stress on the frame which aggravates the tendency to fracture or loosening. Some of these frames are much narrower than the width between the springs, and the spring hangers are bent or splayed out to reach the springs after the manner of construction adapted in some pony traps, for which it is satisfactory. But for the heavier load and much higher speed of the automobile it is not

desirable. A frame which has some diagonal stays or parts which act as diagonals is very desirable, though few car frames are so made. Diagonal staying prevents some of the injurious racking stresses, and with the longer distance between front and hind wheels now common there can be little difficulty about their use.

Wheel-base.—In the earlier designs of cars the wheel-base—that is the distance between the axles—was made short in accordance with ordinary carriage-makers' practice. This reduced the length of road covered, but its disadvantages are serious. A long wheel-base is desirable not only for steady running on straight roads, but for the greater security it gives in running on greasy and bad-surface roads, and on curves and downhill. It also gives greater certainty and definiteness to the steering. A very short wheel-base car is difficult to keep in a steady line, and it will easily turn quite round when side-slipping occurs. The farther the axles are apart the greater is the resistance to side movements and side-slip, the steadier and easier the steering. Long wheel-base lengthens the frame and makes extra care necessary in securing sufficient strength, partly because of the greater length unsupported between the front and back springs.

Springs.—The length and the number of plates in springs of the motor-cars of similar weight and power by different makers vary very much, and without much reason. More attention would no doubt be paid to this point were it not that the general use of pneumatic tyres hides imperfection in this respect as well as others. Springs of insufficient strength, and particularly of the front or steering wheels, are a source of great danger, and frequent careful examination should be given them; but springs are not necessarily of insufficient strength because they appear to be light. Short springs are generally undesirable, as being more liable to break with an ordinary range of flexure than the longer spring, the bending per unit of length being greater. Stiffness in short springs is avoided by lightness, which is likely to lead to breakage, especially when the hole for the pin through the centre is not made as

small as possible, and when the spring rests upon too long a seat under the strap bolts. All the conditions as to best thickness and number and width of spring leaves are best met by springs of the longer type. They should always be bedded upon the axle, with a piece of leather between them and the axle and between them and the clip bolts holding them on. Whenever possible a hard rubber buffer should be attached to the centre of the spring as a chock-block, to avoid the severe shock to springs when the frame goes down the full range of the springs, as when running over a gutter.

The breakage of a spring leaf most frequently takes place at the centre of the leaf, where the contrary flexure occurs between the two clip bolts. A broken leaf may thus be made to do duty temporarily by clipping it up to the other leaves by means of clips which can be bought for the purpose, and one of which at least should always be carried with the spare parts on a car.

Generally a car suspension consists of four springs all placed longitudinally, one to each wheel, but some cars, such as one or two of the American steam and electric motors, are fitted with cross springs at the back. These are not sufficiently general to make any special reference to them any more necessary than are the springs themselves.

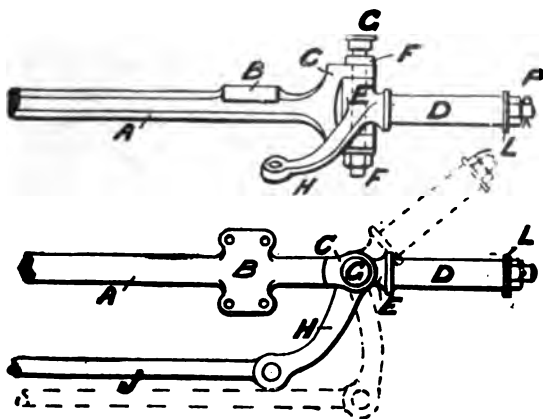
Springs are connected to their hangers at one or both ends by means of a pair of links, which radiate to allow for the bending and straightening of the springs. These links are often much too short for free movement, sometimes not more than $1\frac{1}{2}$ inch between the centres of the pivoting bolts. These should never be less than 2 inches, and 3 inches is better, even in voiturettes, and more than 3 inches in the larger cars.

Very considerable direct and indirect stresses are visited upon the bolts and nuts by which spring hangers are fastened to the frame, and these should be examined from time to time, although they are fixtures.

It should always be remembered that the breakage of a front spring may not only of itself be the cause of a severe

accident, but that even when the breakage is only partial it will cause the steering gear connections to become inactive or be moved with difficulty, and this is very likely to lead to disaster.

Axles.—In all modern motor-cars, with one exception, the front or steering axle is, as to the greater part of it, a fixture to the spring and frame, just as is the hind axle of a brougham. The ends only of these axles move for steering, namely the part which is in the wheel and a short piece which is jointed to the fixed part of the axle. The most common form is as sketched in figs. 1 and 2, which are a side elevation and plan of one end



Figs. 1 and 2.—Typical Ackerman Steering Axle

of a steering axle. In these A is the fixed part of the axle, B the pad upon which the spring is fixed, C the forked end of the fixed axle, and D the movable part pivoted at E in the fork on the pin F, the head of which carries a lubricator at G for supplying oil or grease to the pin. On the part E of the pivoted axle is an arm H, by which through a connecting-rod J, actuated by connections with the steering handle or wheel, the axle D is moved to any angle for steering, as indicated by dotted lines. All the pins and nuts on these connecting-rods and arms need the most careful attention, and frequent

scrutiny to prevent wear or the loss of nuts and pins. The buyer should avoid a car with insufficient strength or quality of work in these parts. This form of axle, known in this country as the Ackerman axle,¹ though invented by M. Lankensperger in 1818, is of very great value in motor construction, as the ordinary carriage front axle, with locking plate and centre pins, would not only be extremely inconvenient, but it would not give so stable a car under the higher speeds at which cars are driven round corners, the wheel base with Ackerman axles remaining nearly the same when turning a corner as when running straight.

These advantages are obtained with the disadvantage of the jointed short arm at each end with its attendant joint pin, nuts, and lynch-pin and lubricator. These are not really any trouble except to those who look upon anything with more machinery than a wheel-barrow as being complicated, and they should not of course undertake to run an automobile. There are numerous forms of this axle, differing in form of pivot and as to the method of holding the road wheel on the axle D, which in the form shown is kept in place by a washer and nut N and a split pin P. All these details are like those of well-known forms of carriage axles, but some, such as the Wolseley car axles, run in ball bearings, and these any cyclist will soon understand. The strength of the fork A is much increased by the firm holding together of the two jaws by the pin F, and hence it is necessary to see that the nut at the bottom is so used that it does hold the jaws together, and it must not be allowed to become loose.

The hind axles of nearly all the chain-driven cars is a fixed axle similar to but stronger than ordinary carriage axles, and they require the same but more frequent attention. The driving wheels on these axles have sprocket wheels fastened to them, and are driven by chains which run upon them and on the smaller sprocket wheels or pinions on the ends of a spindle which is driven by the motor. This spindle is in two parts, connected by gearing, which is known as differential or com-

¹ See 'Mo or Vehicles and Motors,' p. 567.

pensating gear, its object being to drive the road-wheels so that though both are turned by the same rotating source, they may turn at different speeds when turning a corner; the two wheels then describe parts of two circles of different sizes, the one wheel advancing perhaps five or six feet to one foot of the other. The differential gear will be explained with reference to the live hind axle. If both wheels were driven at the same speed on a spindle without differential motion, then one or both wheels would have to skid and rub over the ground for the whole of the difference of five or six feet to one. Railway and tramway wheels do this, but the curves they traverse are, except on tramways, always much larger, and the difference between the curvature followed by the two wheels is small. On tramways, however, it is the cause of very great strains and wear, and is a very unmechanical and barbaric form of simplicity.

So far as driving is concerned the automobilist has only to remember with regard to the fixed hind axle that the axle should be kept well oiled, and that careful examination should frequently be given to all nuts and pins.

The Differential Gear.—The live hind axle used in so many of the more recent forms of light car is a very different thing, and needs more attention, as part of its structure is the differential gear.

The differential gear acts on the principle of the action of the pair-horse whippetree and equalising bar, the gear acting continuously in a rotating circle while the whippetrees act only through a small range rectilinearly.

The gear may be explained by reference to the diagrams figs. 3 and 4, which are merely for explanatory purposes.

In fig. 3 wheels A and B are supposed to be upon an axle in two parts, C and D, united by a pin at E loose in both parts of the axle. Fixed on both parts are arms F and G, connected by a loosely-fitting cross-piece H, supposed to be pulled at K by a rod J. It will be readily understood that if the carriage of which A and B are the driving wheels be set to move in a straight course and the road resistance to both wheels be the

same, then *H* will remain parallel with the axle. If, however, the steering wheels are set to turn a corner, the wheel *B* being on the inner or smaller curve, then the wheel *A* will have to move faster than *B*, and the arm *F* will be pulled through a greater angle than the arm *G*, and the cross-piece *H* will cease to be parallel with the axle. The parts will take the positions shown by the dotted lines. Such an apparatus could only act through part of one revolution of the wheels, but so far as it acts, it permits the pull on either wheel to remain of equal value, though one wheel moves more quickly than the other.

The principle illustrated by this diagram may now be followed in fig. 4, which illustrates a common form of live axle

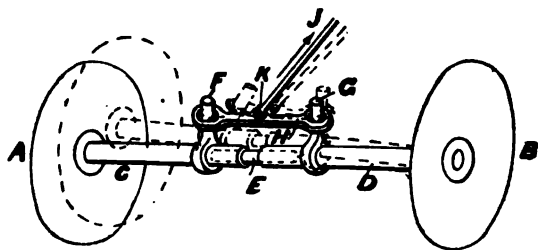


Fig. 3.—Diagram to illustrate Differential Action

driven by a horizontal jointed rod from the motor and a bevel pinion. The functions performed by the parts are the same as those having the same letters in fig. 3.

The differential gear consists of two bevel wheels *F* and *G*, each tooth of which acts in the same way as the arms *F* and *G* of fig. 3, and two or more bevel pinions *H* each of which acts in the same way as the cross-piece *H* in fig. 3, but by means of its teeth bearing upon the teeth *F* and *G* of the bevel wheels instead of the one tooth or arm *F* or *G* in fig. 3. These bevel pinions are loose upon the pins on the end of the piece *K*, just as the piece *H* is loose on the pin *K* in fig. 3, but instead of the pin *K* being pulled by a rod it is carried round by the bevel wheel *J*, acting in the same way but

rotatively instead of through a horizontal line of short range. If now the resistance to the wheels A and B be the same, the pinion H (acting in precisely the same way as the cross-piece H of fig. 3) will by its teeth at F and G impart equal degree of rotation to both, but if wheel B be on the inner side of a curve or meets with obstruction greater than that to A, then the pinion H will turn on its pin K, and allow one wheel to move faster than the other. That is say, the pinion H will impart the same push to either wheel A, B, and if one of these moves more easily than the other from any cause, it accommo-

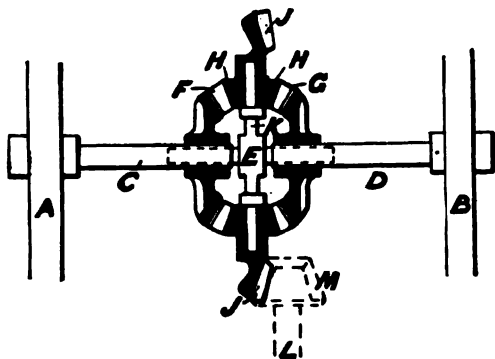


Fig. 4.—A Differential Gear

dates that wheel by itself turning and allowing the wheel to move more rapidly than the other. This accommodating action of the gear is important for free turning of corners, but it has its disadvantage, in that if one wheel, while the vehicle is on the straight, meets with more obstruction than the other, the gear allows it to be obstructed, and tends to push the other wheel round against the action of the steering gear. Correspondingly, if one wheel is on a greater thickness of greasy mud or a more slimy bit than the other wheel, it has more freedom of, and help to, rotation than the other, and skidding or side-slipping on the greasy road results and is aggravated. Hence

in the heavy steam lorries, means are provided for throwing the differential gear out of action.

On many cars the bevel wheels of differential gear were too small in diameter, and hence there was insufficient room to get in pins of sufficient size to carry the pinions H, and rapid wear and breakage took place. In any case it is necessary to have ample diameter for these parts, and to see that they are kept well oiled, not only at the pins and gear teeth but at the centre of the axle, where the two parts are joined by means which allow them to rotate differentially on a centre pin and in the bearings in the differential gear-box which surrounds the wheel J. This box is not shown in the diagram, fig 4. The dotted lines at M indicate the bevel pinion on the spindle I, which is driven through a jointed rod by the motor. The means of transmission of the power to this spindle have been described in other chapters. The automobilist should occasionally jack up the rear of the car so that both drivers are free of the ground, so as to see that the wheels run equally free when either wheel is held, thus testing the free working of the differential gear, finding slack if it exists, and testing generally the condition of the gear and connections.

Steering Gear.—The loss of a ship's rudder is a small loss comparatively with that of the breakage or carrying away of an essential part of the steering gear of a motor carriage, especially of a high-speed car. The ship will continue to float and in most cases the stopping of the engines removes immediate danger from collision. With a broken steering arm or connecting-rod a car with its occupants may be hurled into a ditch, or ravine, or river before the driver has realised what has happened, and long before the brakes could do any good. The first provision against the helplessness that must, and the disaster that probably would, follow broken or disconnected steering gear, is sufficient strength in the parts. It should be as direct and simple in arrangement as possible, because least liable to disarrangement and because gear with chains and short rods and connections through springs have so many

more points for possible looseness and losses and more to examine and yet be uncertain about. A few pounds in weight will make all the difference between weak and bending untrustworthy parts, and certainty, so far as strength will give it. The second means of providing against accident is frequent minute inspection of every connection, tightening of nuts, renewal of worn pins, assurance that pins cannot leave their place or split pins be lost, and careful oiling and covering of joints so as to prevent ingress of grit and reduce wear as much as possible.

The choice between locked steering gear and what is commonly called direct steering gear is very much a matter of personal choice. The locked gear generally acts through a worm and wheel or quadrant, and remains where it is set by the driver. The free or direct gear moves with the impulse or pressure brought against the steering wheels or one of them by any ruts or obstructions on the road. This movement has to be resisted by the hand of the driver, as it is in some of the steam-cars with lever-steering handle and many of the wheel-steering light cars. An objection to the locked steering gear is that the worm gear rigidly holds the whole of the connections between it and the steering axle. Hence any shock by blow or heavy push at one wheel has to be withstood in all its force by the steering connections. The lever or free gear on the other hand is not rigid. It is accommodating, and the shock on the steering parts is very much lessened, and in many cases eliminated, by very small movement of the steering lever or wheel. The objection to this is that the hand has to accommodate itself to and permit this movement and still preserve the steering control. If it be resisted the hand and arm feel in a very disagreeable way the effects of the shocks, especially at high speeds on bad roads, and of which the steering gear is relieved. The driver, however, soon learns to keep a loose but ready hand on the steering wheel or lever just as in riding a bicycle or tricycle. On very light and moderate speed cars lever or free-wheel steering gear would seem to be in every way sufficient and quicker in action than the locked gear, and

while running on good smooth roads there is very little tendency for the steering wheels to wander one way or the other.

For the heavier and higher speed cars the locked steering will probably continue to be preferred, the steering connections being relieved to some extent of the severity of shocks by the interposition of spring buffers in the rod ends, thus securing the advantage of fixity of position of wheels and direction of running under any circumstances. It may be remembered, however, that with the long wheel-base of the passenger brakes run by the Lifu Company two or three years ago, the lever-steering worked with great ease at thirty-five miles per hour, but the axles of the wheels were inclined so that the point of incidence of the wheels on the road was directly under the steering-axle pin, and hence most of the shocks were delivered to the axle and not to the steering gear.

The automobilist should frequently jack up the front of his car so that the front wheels are free of the ground. Then he can test the condition of all the steering-gear parts between axle-arm and steering pillar, and see and feel every joint and find out where, if any, and how much looseness or wear there is in any part. He cannot do this properly while the weight is on the wheels. Looseness between steering wheel and end of steering pillar can be found at any time. He should never allow 'hurdle fitters' or 'horseshoe fitters' to attempt to refit or alter any part of his steering or other gear, any more than he would allow a 'hedge carpenter' to alter or repair the body of his car or the Chippendale chairs in his drawing-room. Only good experienced workmen, and above all trustworthy workmen, should be allowed to do this work. The refitting of steering worm and quadrant or of the nut on steering screw, when that form is used, must be done by a good fitter, unless the double nut, with one half adjustable independently of the other, is used.

Brakes.—Next to trustworthiness in axles, wheels, and steering gear the sufficiency and certainty of action of the

brakes are of the utmost importance. So long as the axles do not break and the steering gear steers, an expert driver can rub along with very poor brakes until familiarity with risks and dangers leads him into a smash, or until some very near squeak makes him shudder when he thinks about it after he is in bed and the light out; and then he looks to it on the morrow. Of these incidents we do not hear much, but we all know of the smashes and the fatal accidents that have happened to those on runaway or brake-given-way cars, and Mr. Hutton's narrow escape at the end of an unwonted rush downhill into Grantham, and Mr. Graham White's run-away at Dover, are instances of the more obvious kind of evidence of the necessity for good brakes. For the beginner there is no working part of a car so necessary to his safety as the brakes. He finds that stopping is very frequently more important than going if he values either his life or that of others, or wants to save his car and is not anxious to pay for smashing carriages or horses. Even the makers of the lighter French vehicles no longer fit their cars with brakes not big enough for a bicycle or good enough for a horse-rake.

Many brakes have in the past been generally made or fitted so that they will only hold a little in any direction, some that would only hold well in one direction, and some that held too well, came into action too severely, in one direction, namely forward, and very few that held well in the backward direction. A great deal of attention has lately been paid to this question, with the result that brakes long well known to mechanical engineers have been applied to motor vehicles.

A common form of brake that will hold only in one direction is shown in diagram fig. 5. In this a brake drum *A* is surrounded by a brake band *B*, fastened at one end to a fixed stud at *C*, and pulled at the other end *D* by a rod *F*, connected to a pedal *E*. This brake acts perfectly so long as the drum *A* rotates in the direction shown by the arrow, because the friction of the band on the drum from near *C* to *D* pulls on the band in the same direction as the pedal, and thus the greater the pull

at D the greater the frictional grip round to D. As soon, however, as the car is reversed or moves backward, so that the drum turns in the opposite direction, the friction of the band upon the drum pulls the band round towards the fixed point *c* and further frictional grip does not take place, as the tendency is to reduce the pull on *c*. If now the band be coupled at *c*

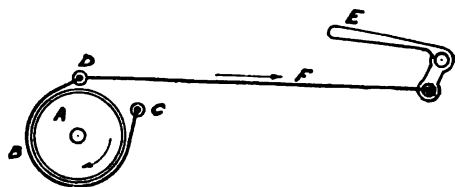


Fig. 5.—Brake which holds in one direction

to a lever pivoted at H, as in fig. 6, the other end being coupled to the end D of the same lever and pulled by the rod F and pedal E, the brake will act both ways. If the drum be turned in the backward direction of the arrow, the pull at D will not be lost through the effect of the fixity of the point *c*, for both ends

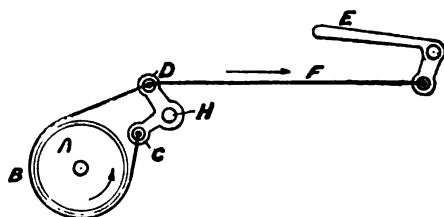


Fig. 6.—Brake which holds in both directions

c and *D* are pulling on the drum and increasing the pull on *F* increases the frictional hold in a rapid degree.

A good form of brake is that shown by fig. 7, in which the pull on the rod *F* from pedal *E* pulls the arm *D*, and thereby pushes the links *c* outwards and forces the blocks *B* outwards into the brake drum ring *A*, the whole of the brake tackle

shown being prevented from rotation by the radius rod *c*, attached to the frame. It will be seen that this brake holds equally well in either direction. It is made by Messrs. James and Brown.

Other forms of brakes which act in both directions have been adopted, as in the Cannstadt-Daimler cars, the Riker, the Panhard Krebs car, the Electric Vehicle Co. and others, and more recently by Darracq, De Dion, Bouton, and Decauville, but many are still fitted of the untrustworthy kind. These are types, and all but the substantially made and well connected brakes should be avoided.

Brake bands with wood blocks attached will work very well, but well-fitted bands with metal-wearing surfaces are much

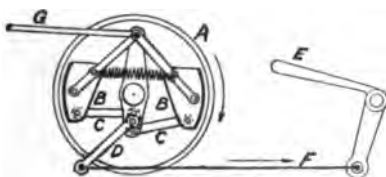


Fig. 7. -Brake which holds in both directions

better, and brakes made up of small wire ropes and tacked or tied on or threaded wood blocks are not to be encouraged.

However good the brake, it needs careful inspection and occasional adjustment, and much more thought than is usually bestowed on so important a factor of safety.

A fruitful cause of accident and of wear and tear of brakes, tyres and car generally, is the abuse of a good firm-holding brake. Maintaining high speed to the last moment and depending on sudden application of the brakes is a very bad and often dangerous practice.

The injudicious use of brakes or the rash driving which entails the excessive employment and the abuse of brake power, is not only to be condemned because it is so likely to cause the breakage of the brake gear, and so render a driver

absolutely helpless, but because it is one of the fruitful causes of rapid tyre wear.

When a car weighing with its passengers one ton is stopped from a speed of 20 miles an hour in a length of say 15 yards, the accumulated energy in the mass in motion is about 13 tons, and this is dissipated by work done on the tyres. It is remarkable that even the best of tyres stand this enormous strain as they do. At 20 miles per hour the car travels 45 feet in the time taken to stop it, but the Automobile Club trials of January 1902 show that the distance in an assumed emergency stop may be much shorter than this, and it will not be an exaggeration to assume that the car may be stopped in 35 feet or in from $2\frac{1}{2}$ to 3 seconds; and in this space the wheels will have made only from four to five revolutions, according to their diameter.

The whole, then, of the work, equal to that of raising a ton 13 feet high, is done by the tyre surfaces in four or five turns, or less than three seconds. This statement is sufficient to enable even those who have the very least acquaintance with mechanical matters to appreciate the danger and the costliness of the injudicious driving that leads to the abuse of the brakes.

It may be desirable to record here that the Automobile Club brake trials above referred to showed that on a flat and nearly dry good road a car could be stopped at the speeds and in the car lengths given below :—

From 11 to 14 miles per hour in $1\frac{1}{4}$ car length.

From 15 to 17 miles per hour in 2 car lengths.

From 18 to 20 miles per hour in $2\frac{3}{4}$ car lengths.

From 20 to 24 miles per hour in $3\frac{1}{2}$ car lengths.

Wheels.—For *voiturettes* there does not appear to be any structural superiority in wood wheels, making them in this respect preferable to well-made and well-proportioned wheels of the cycle type. They are a little more easily cleaned, and are, perhaps, neater in appearance; but even this is doubtful in very light cars. For the heavier cars the wood wheels of

the Hancock type are preferable because of their combined strength and resilience, as well as for advantages as to cleaning and appearance.

There are, however, no points in particular that the beginner has to consider except to beware of wheels made with very light spokes and felloes. Look well to the joints in the felloes and every joint of every adjoining spoke in the bosses. Well-made wheels show no movement at these points after hundreds of miles of running. For the most part the buyer must rest upon the honesty and reputation of the maker, but he may help the longevity of the wheels by judicious and gradual use of clutch and brakes, and by guarding against loose or lost nuts on the wheel boss flanges or slackness on the axles. Any slackness of the rim on the felloes should be attended to by a wheelwright. The cycle wheels of the light voiturette seldom require attention except in case of accident, and they may generally be entrusted to any of the accredited repairing shops.

As a rule it may be taken that the larger the wheel the smoother the running of the car. Very small wheels are to be deprecated on this ground, and also because the severity of the shocks to the whole car increases very rapidly on bad roads with decrease in diameter of wheel, for reasons which have been given in the book already mentioned.

All the wheels should be of the same size, because the same tyre will then fit any wheel, and half the number of spare covers and inner tubes are required as compared with the requirements when the wheels are of different sizes.

The appearance of a car with wheels of equal size is moreover better than when the steering wheels are smaller, and except that custom, dictated by the old locking plate and centre pivoted axle, required the small wheels in front, there is not only no reason for small steering wheels in motor carriages, but if any difference is made they should be larger than is necessary for the driving wheels.

CHAPTER XI

TYRES

BY C. L. FREESTON

It is a curious paradox, but none the less true, that while the public has still to be converted to a more widespread appreciation of the efficiency of the mechanical motor, to the automobilist himself the problem of the day, and of many days yet to come, is how to find a perfect tyre. Excellent motors have been in use for years—in fact, it may be said that in actual practice the engine is the least likely portion of the car to fail; and though improvements have been effected, and others will yet be introduced in this and other parts of the machine, to the gratification of every driver, he would willingly resign them all and use, say, a Daimler motor of 1896, if only he could be ensured entire immunity from tyre troubles. No one is exempt from this apparently chronic obstacle to pleasurable driving; the novice with his first car experiences sundry mechanical difficulties which the experienced hand may avoid, or quickly conquer if they occur, but every automobilist alike is a prey to the inconvenience of punctures, and the expense of upkeep of a costly and too easily perishable tyre equipment.

Arguing from the analogy of the cycle, in respect of which the use of the pneumatic tyre has been so signal a success, the average reader may find it difficult to understand why the motor-car tyre should not be just as satisfactory, provided that its substance be increased in converse ratio to the weight it has to carry and the work it has to do. This, however, is unfortunately the crux of the whole matter. Various factors

enter into the situation which are virtually unknown in the case of the ordinary cycle. The motor-car not only surpasses in speed the greatest efforts of the cyclist, but also maintains a high momentum for protracted periods ; hence overheating is one factor, not to mention others, which is present in the motor-tyre, but which in cycling is only known to the Alpine rider who 'coasts' for twenty miles or more with the brakes on all the time. The motor-car, too, must be driven through everything, including long patches of 'new metal,' and must take its grip on bad surfaces as well as good ; the cyclist, on the other hand, can often pick his way, and, if not, can get down and push his mount, the tyres thus making a rolling contact only instead of sustaining the driving friction which does all the harm.

With all its drawbacks, however, the pneumatic tyre is almost indispensable for most types of motor-carriage. In speed, in comfort, in saving the mechanism from pronounced concussion, and in facility of steering, there is no question as to the superiority of the air chamber as compared with solid rubber. The curious fact, moreover, remains that in the very circumstances which emphasise the weak points of the pneumatic tyre the solid would be even worse. High speed and a heavy car form a combination which tests the pneumatic tyre severely, but the solid tyre in like circumstances can with difficulty be kept on the wheel at all. At high speed, again, the pneumatic tyre is particularly liable to puncture ; but the very fact of the tremendous speed necessitates the rejection of the solid, because the comfort of the passengers, the conservation of the mechanism from jar, and the ease and safety of the steering become more than ever important.

It is a melancholy fact that our French neighbours have all along been even more ahead of this country in regard to the manufacture of motor-tyres than of motor-cars themselves. This circumstance for years pressed very hardly on the English amateur. In 1901, however, the Dunlop Company permitted the tyre which was most favourably known abroad, i.e. the

Michelin, to be imported into the United Kingdom under licence, as the 'Clipper-Michelin,' and it at once became the standard type of pneumatic tyre among British users.

THE CHOICE OF A TYRE

Assuming that the reader is purchasing a car for the first time, he may reasonably specify the fitting of Clipper-Michelin tyres and leave experimenting, if so inclined, until a later date. This type of tyre is taken as a standard for purposes of description and illustration of the processes of repair.¹ Several items, however, require previous consideration. It is more than likely that though the right make of tyre be chosen the novice may go wrong as to certain points of detail. In the first place it is of the highest importance that the diameters should be correctly apportioned to the weight, and secondly, whatever the size of cover, that it should be of the correct degree of substance. Thirdly, it is advantageous that all the wheels should be of equal size.

As regards diameters, it may be stated that the Michelin tyre is made in various sizes, ranging from fifty-five to one hundred and twenty millimetres, or two and a half inches to four and three-quarter inches. The tendency of makers is to fit too small a diameter, and in most cases it is safe to ask for one size larger than that which is offered. In the 'Guide Michelin,' however, a complete table is provided in which the suitable diameters for given weights are specified, together with the degree of inflation to be allowed, and these data should be studied with due care. The 'Guide,' a most useful volume of 575 pages, is included with the Michelin repair outfits, or may be obtained gratuitously from the firm. With regard to substance, the covers are of three types, the *léger*, the *renforcé*, and the *extra-fort*. The first-named may be discarded altogether, the second fitted to the front wheels if the

¹ Figures 1 to 16 have been selected by permission from the excellent *Guide Michelin* and redrawn, in some cases with slight emendations.

car be very light, while the third should invariably be chosen for the driving wheels, and preferably for the front as well. It is well to bear in mind that the average English road is not as good as the average French road, and to make allowances accordingly.

REPAIRS

The repair of a Michelin motor-tyre approximates to that of an ordinary cycle-tyre with beaded edges, save that much greater resistance has to be overcome in the former type owing to its substance, while the winged nuts add one new feature of complication. On the other hand the motorist has full access to the wheel, and has no fork-blades to impede his operations. While it is probable that most automobilists will have previously become acquainted with a cycle-tyre, it is desirable to describe the repair processes throughout.

It is essential that a satisfactory repair outfit should be obtained at the outset, and nothing on the market can be compared with the Michelin *nécessaire de voiture*, which is worth buying if only for the special levers it contains, apart from the excellence of the tackle generally. One of the levers (see fig. 1) has three projections intended for use with covers of 65, 90, and 120 millimetres

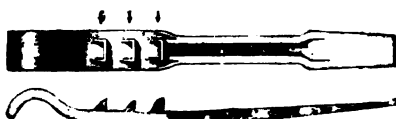


Fig. 1

respectively; the other lever has a hook which comes in handily when replacing a large cover (see fig. 13). The larger the tyre the more essential are the levers; a new cover is also much stiffer than one that has been used for a considerable time. In the case of a small or medium-sized tyre, not too new, a very strong pair of hands may render the levers superfluous.

When the driver has reason to suppose, from the bumping of the car on one side, that a tyre is punctured he should stop at once to examine. It is of the highest importance that a tyre should not be ridden deflated, but it is not always easy to

detect the fact of a puncture at once in a back tyre, when the road is itself bumpy. In a four-seated car the rear passengers should glance occasionally at the driving-wheel tyres out of consideration for the driver, and if either of them be splayed at the point of contact with the road he should be apprised of the fact at once.

If he decide, upon dismounting, that the tyre is punctured, and not merely short of inflation, the car should be jacked up so as to permit free movement of the wheel. The tyre should then be cleaned, the best article for the purpose being a brush with wire bristles; the type is known as a 'jeweller's scratch-brush.' Loose dirt should also be wiped from the spokes. If these precautions be neglected every movement of the wheel

will cause particles of dirt to fall into the hollow of the cover, whence they must be removed at all costs. If a cloth be damped with water or petrol the dirt will cling to it readily, and can be quickly wiped away.

To Remove the Tube.

—To remove the air-chamber for examination the valve cap should be unscrewed and inverted, the pin being then pressed into the valve stem so as to push away the needle (see fig. 2). Deflation may be expedited by loosening the large nut, and pulling out the plug,

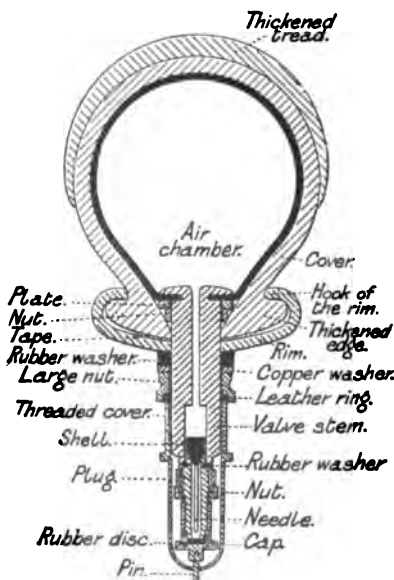


Fig. 2

especial care being taken not to lose the little needle with its shell-shaped head. Then unscrew the winged nuts almost as

far as they will turn without detaching them from the bolts, and push the latter upwards until the nuts meet the rim.

The beaded edge of the tyre should then be forced inwards all round the rim by the left hand, the right hand assisting the operation by inserting the point of one of the levers. Then moisten the blade of each lever to make it glide more easily on the rubber. Take hold of the cover, as in fig. 3, with the left hand, at a point between two winged nuts, and not near the valve. Push forwards with the palm of the hand and the thumb, and simultaneously, having inserted a lever, work it downwards with a laterally oscillating movement until it assumes the position shown in fig. 3. Depress the haft until the blade is horizontal, and then slowly work the point again



Fig. 3

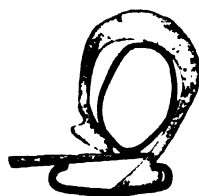


Fig. 4

with a sideways oscillation, until the opposite edge is reached, as in fig. 4. Still holding this lever firmly, insert the other at a point from ten to fourteen inches away, according to the size of the wheel; roundly speaking, the distance between the levers should be a third of the diameter of the rim. Avoid, however, placing either lever near the valve or one of the winged nuts.

Having worked the second lever forwards in like manner to the first (see fig. 5) depress the hands towards the hub (see fig. 6). This should bring the beaded edge right over the rim; if the movement fails the levers are too far apart, or if the edge comes over but slips back again they are too close. The remainder of the cover may be detached with the hands alone in the case of a voiturette tyre, but otherwise the right-hand lever must be re-inserted six inches further down, and again

depressed, the process being repeated until detachment is complete. Care should be taken that the winged nuts remain flush with the rim throughout.

If a single lever only be available the removal of a cover requires more strength and more dexterity. The left hand should



Fig. 5



Fig. 6

press the cover outwardly as much as possible, the point of the lever should be insinuated between the beaded edge and the rim, but not beneath the air-chamber, and the position shown in fig. 7 should be attained, by pulling the cover forward with

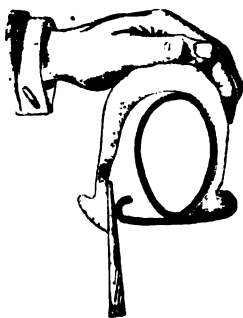


Fig. 7



Fig. 8

the left hand and depressing the lever with the right. Avoid the position shown in fig. 8. Slide the lever, which should be moistened, between the rim and the beaded edge, and as the latter is progressively unhooked press downwards on the cover, as in fig. 9, to prevent any slipping back. The case or other-

wise of the removal with one lever depends upon the size and age of the tyre; two levers are in most cases to be preferred.

To save time on the road it is usual to remove the air-chamber bodily and replace it with a new one, deferring the repairing of the puncture to a more convenient occasion. In this case the valve should be loosened by unscrewing the large nut and rubber washer, and pushing the stem upwards until it leaves the rim. The air-tube should then be detached all round with the fingers, great care being exercised lest the rubber be adhering to the lining of the cover, owing to an insufficiency of chalk having been employed when the tube was last fixed, and also lest, as is very probable, the nail, flint, or other puncturing instrument, be still lodged within the cover, in which case ungentle handling may tear the tube. If the cause of the puncture be found, or even if there be a visible cut right through the cover, the corresponding spot on the tube should be determined, when a hole will probably disclose itself if the rubber be slightly stretched. The puncture should at once be marked with a coloured



Fig. 9

pencil, whether the tube is to be repaired forthwith or not. Then remove the nail, or other cause of damage, from the cover without fail.

If no spare tube be available, and the one *in situ* must be mended there and then, it is not necessary to loosen the valve in the first instance, as the puncture will probably be easy to locate, and may be at such a distance from the valve as to render a repair feasible without removing the entire tube. If the valve has to be detached, however, and the cover is of 90 mm. diameter or more, the lever with three projections should be employed, as in fig. 10, to hold up the cover.

To Repair a Puncture.—This process is simple. Select a

patch from the repair-box, of small size if the puncture be a mere perforation, but larger if the tube be cut. Clean the tube round the hole with glass-paper or petrol, brush dry, and then apply solution, over a space somewhat larger than the patch. Next cover the patch with solution also, on the side that is not bevelled. In each case the solution should be thinly and evenly spread, not in clots. Wait until all traces of moisture have disappeared—a point of paramount importance—and then fix the patch upon the tube, pressing the surfaces firmly together. There should be no ambiguity about the adhesion; the patch will stick like a leech at once if the solution has been thinly applied and sufficient time—from five to ten minutes—allowed for it to dry.

To Repair the Cover.—Before replacing either a new or repaired tube the cover should be attended to. If the hole or cut be very small, it will suffice to plug it with cotton wadding, soaked in solution, to prevent the ingress of water or dirt; the possibility of the air-chamber, however, under strong inflation, forcing its way into the aperture and bursting must be borne in mind, and when doubt exists as to the safe course to follow an oblong patch of canvas should be applied instead. The lining of the cover should be cleaned with glass-paper and solution spread on the fabric and on the canvas patch, as described above in the case of the air-tube. Apply a liberal dose of powdered chalk to the patch when fixed.

Replacing the Tube.—Considerable care is requisite when inserting an air-chamber. It should first be plentifully chalked, and a handful of chalk should also be placed in the well of the cover, and distributed by revolving the wheel two or three times. The opposing surfaces are thus well lubricated, and the possibility reduced to a minimum of nipping the tube, a factor which M. Michelin has declared to be the cause of fifty-one per cent of the injuries to air-chambers. Ensure that the tube is entirely deflated before replacing; to effect this it must be rolled upon itself and all the air squeezed forwards towards the valve, all the parts of which

must previously have been detached excepting the plate and nut at the base of the stem. Before replacing the tube, see that the overlap at the join is facing towards the back of the car, and not forwards. Then push the stem through the rim, meanwhile holding up the cover as in fig. 10. Place the rubber washer and large nut on the stem, but do not screw right home. The tube should then be passed round the bed of the rim, without any twist, and without being slack at one point and stretched at another.

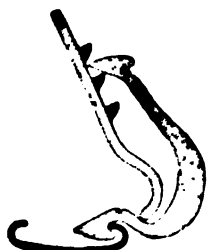


Fig. 10

Now insert the remaining parts of the valve, except the cap, and inflate slightly, just sufficiently to make the air-chamber round, but without the least stretching of the rubber. Then pass the hand all round, between the tube and cover, to make sure that no creases remain.

To Replace the Cover.—Unscrew the rim nuts sufficiently to allow the valve to be pushed upwards, and the beaded edge to pass into its place. Force as much of the cover into



Fig. 11



Fig. 12

position as is possible by pressure from the hands, and then insert the lever as in fig. 11, and by lateral oscillation work the remainder into the hook of the rim. If the cover assumes the position seen in fig. 12 replacement will be difficult. In that case fix the lever with a single prong in the position shown in fig 13, and depress the other lever. Then bring the levers towards each other, and push the cover along the

inclined plane formed by the lower lever, as in fig. 14. Withdraw the upper lever, and, by raising the other lever, force the cover into the rim, afterwards tucking the edge beneath the hook by reiterated pressure from the point.

As each bolt is reached it should be pushed upwards as far as it will go when the winged nut is unscrewed to the last limit, and when the cover is in position all the way round these bolts should be worked up and down to determine whether the tube be nipped. The movement will, in that event, release the tube, and the bolt should come back much as the key of a pianoforte after pressure from the finger. If the bolt cannot be pushed upwards the beaded edge is not accurately bedded.

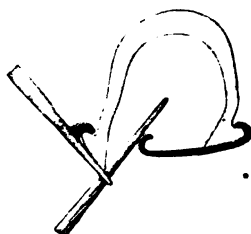


Fig. 13

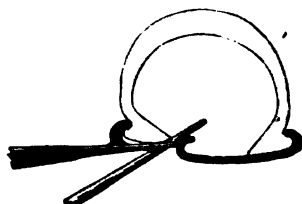


Fig. 14

It now remains to ensure that the air-chamber is nowhere nipped. Seize the cover with both hands, and with the thumbs force the beaded edge towards the centre of the rim. Make the circuit of the tyre in this way, and if the red tube be nowhere visible it is not nipped, but if it project at any point it must be pushed inwards with the lever.

The tyre may now be inflated, care being taken, in order to avoid wasted effort, that there is no leakage between the nozzle of the pump and the milled cap into which it is screwed, or between the latter and the rubber pipe, or between the nozzle and the valve. After inflation see that the valve nut and the winged nuts are tight to the rim, or wet will penetrate to the tyre.

To Change a Cover.—Remove the inner tube, then detach the winged nuts and take out the bolts. Pass a lever not only under the detached edge of the cover but also beneath the one opposite, as in fig. 14. Depress the lever, and pull the cover forwards. As soon as about eight inches of cover have been levered off, the rest can be removed with the hands.

Replacing a Cover.—In this operation the beaded edge on the far side must first be fixed, care being taken to have the notch exactly opposite the valve hole, and that the cover does not pucker in one part and stretch in another. Insert the bolts in turn, holding up the cover as in fig. 10. Then replace the air-chamber as *ante*.

Bursts.—Bursts of the air-chamber, if not more than four or five inches long, may be repaired in the same way as a puncture, using a very wide patch, however, and affixing it with extreme care. A large burst in the outer cover may be temporarily repaired by solutioning to the lining a specially stout patch made of two thicknesses of canvas with an insertion of vellum. The cover may also require to be laced up with a large bandage of leather. As soon as possible, however, the tyre should be sent to the factory.

GENERAL HINTS

Watch the winged nuts, and keep them always tightly screwed to the rims.

Wash the tyres occasionally with petrol, and examine for cuts. If deep, insert a piece of rubber and fix with solution. If the cuts have gone completely through, plug with cotton wool, and reline the cover with canvas where required. The older the tyre the more carefully must it be watched, and probable bursts prevented by interior reinforcements.

Never drive with a tyre deflated.

Scrupulously keep all wet from percolating into any part of the tyre. Whenever necessary re-enamel the rim and spoke-heads.

Also keep oil away from the tyres, or it will rot them.

Do not be afraid to pump the tyres hard, especially if carrying a full load. They should never splay more than half an inch.

Never let the car rest on deflated tyres.

In the case of wire wheels, make sure that the spoke-heads are properly covered by the tape.

Test spare tubes by inflation in water, for possible minute leakages.

Do not, however, construe air-bubbles from the valve as a sign of permanent leakage. The needle of the Michelin valve does not fit absolutely tight under the light inflation of an unprotected tube, but under full inflation in the cover may be air-proof. A good plan when tube-testing is to stop this slight leakage by moistening the needle in the mouth.

Keep all spare tubes completely deflated and away from the light. Brown paper is a good preservative. Do not wrap up two tubes together, or the pins may cause punctures.

Always carry at least two spare tubes when driving, and more if the wheels are unequal in size. Spare covers should also be carried when those in use are much worn.

Never start a journey without a pump, a lifting jack, and a fully furnished repair box. See, also, that the pump nozzle has not become detached from its socket.

At every stopping-place it is worth while to examine the covers, in case nails or flints have become embedded in the tread.

When a nail cannot be found, in case of puncture, the cover should be carefully examined for possible flints or pins.

Be sure that the wheels are strictly parallel to each other.

To determine whether a tyre is fully inflated, stand on the step and oscillate the car; the expansion of the tyre at its lowest point should be inconsiderable.

The Michelin 'cradle,' or metal nail-catcher, is a useful device to attach to the back wheels, as it may strike off nails

before they have had time to work their way through the tread.

To reduce the probability of puncture in patches of loose stones, let the car run as much as possible by gravity, and not by driving friction.

OTHER TYRES

Various attempts have been made to produce efficient tyres for motor-cars without infringement of the Dunlop patents. At present (1902) there is only a restricted experience to call upon in respect of these new types, but the appended enumeration of their leading features is based upon personal investigations among actual users.

The Collier.—As will be seen from the sectional illustration (fig. 15), this type is provided with an unusually stout tread, and is made in very large diameters. The mode of fastening is by vertical bolts passing through a horizontal flange of metal which is shrunk on to each side of the wooden felloe. The upper ends of the bolts are ringed, and receive a wire which passes all round the bead of the cover, on each side of the wheel alike. To remove the tyre when deflated it is only necessary to unscrew the locking nuts outside the flange, and, as the wire threaded through the rings is not endless, the bolts can be pushed inwards and the edge of the cover lifted without difficulty, especially as it only engages with a flat surface, and not the turned edge of a rim of the ordinary pattern. The cost of the Collier is about 25 per cent in excess of ordinary types. Not only is excellent rubber employed, however, but the system of moulding is such that even on a heavy car the tyres show fewer cuts than solids. I have seen a set of Colliers on a 27-cwt. car that had been driven 2,300 miles over bad roads, and even the covers of the driving wheels were quite smooth

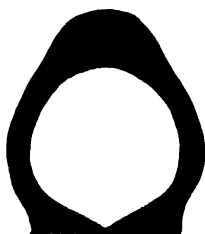


Fig. 15

and unimpaired. The maximum speed of this car was 25 miles an hour ; experience is wanting as to what results would follow the use of these tyres on a high-powered vehicle, both as regards wear on the tread and the strength of the attachment.

The Goodyear.—Bolts are also employed, but in a different way, in the Goodyear (fig. 16), a tyre of American origin. They are passed horizontally, to the number of sixteen, through



Fig. 16

vertical flanges of metal and the intervening wooden felloe. The base of the tyre is thus held by the pressure from the flanges and that of inflation also. Access to the air-chamber is gained by removing the locking nuts and detaching one flange bodily. The cover can then be pulled off its flat bed without any particular difficulty. One of the good points of the Goodyear is that it cannot come off the rim if deflated, nor will it 'creep,' as strands of contracting wires inserted through the base make the circumference constant. To prevent overheating at high speed the fabric has an insertion of asbestos. The Goodyear is very well spoken of by those who have tried it up to now.



Fig. 17

The New York.—Another American tyre is the New York (fig. 17). Unlike the foregoing it is of the single tube variety. It is made in light and heavy patterns, the one illustrated being intended for cars weighing over a ton.

Owing to the uniform thickness of the walls the tyre can be ridden deflated without material damage. It is fastened to the rim both by vertical and horizontal bolts.

NON-SLIPPING TYRES

A tyre which has become popular in France for town and winter work is the *Gallus*. Its use in England is impracticable for the present, both by reason of patent rights and the fact that it contravenes the stipulations of the Local Government Board as to projections being 'of the same material as that of the tyre itself, or of some other soft and elastic material.' The *Gallus*, nevertheless, possesses several interesting features, and may ultimately find its way into the United Kingdom. From fig. 18 it will be noticed that the tread is covered with parallel armatures of metal set in close series. Except for remotely possible penetrations between the plates the cover is unpuncturable; but the *Gallus* is chiefly valued in Paris because of its non-slipping properties. It is employed even on 20-h.-p. cars, and within the speed limitations imposed by town use the armatures do not easily become detached.



Fig. 18

Curiously enough, only one *Gallus* cover is fitted to each car, namely, on the near side driving wheel, the object being to prevent the skid towards the gutter to which a car is liable on greasy thoroughfares. In this country, of course, where the rule of the road is reversed, the safety tyre would need to be used on the off side. The *Gallus* is somewhat more expensive than the ordinary cover; it is also slower, and on hard surfaces is more vibratory; on snow, too, it is ineffective as a non-slipper, owing to the clogging of the apertures. Nevertheless, its advantages are held to outweigh these disadvantages, and during last winter it was largely adopted by leading chauffeurs in Paris.

The Falconnet.—A method of wiring the tread of a pneumatic tyre in order to prevent non-slipping was introduced in

1901 by the Falconnet Perodeaud Co., of Choisy-le-Roi. As will be seen by fig. 19, the cover is full of closely set strands of crimped wire, the points of which project slightly above the tread, and thus present a rough surface to the road. It is claimed that not only is side-slipping prevented, but that the cover is also more durable and less susceptible to punctures. As to its behaviour at high speed no evidence is available.:



Fig. 19

The Wilkinson.—At the Wilkinson Tyre Manufactory, Huddersfield, is made a somewhat similar tread, which can be solutioned on to any cover. The wires in this case, however, are straight, not crimped, and are less numerous; they are also stronger individually, and project further. The tread is made in three sections, and as the wires are worn down the rubber of the external section can be pulled away, the process being repeated after further wear. On light cars there is evidence to show that this tread is satisfactory, and really prevents skidding, even in bad grease, but it has not yet been tried on fast and heavy cars.

SOLID TYRES

The fact that solid tyres are considerably cheaper than pneumatics, and, of course, immune from puncture troubles, causes many automobilists to make experiments in that direction. As mentioned at the outset, however, the solid tyre is most conspicuously wanting under the very conditions when the pneumatic may seem least desirable, but is really the superior type. The problem is curiously complex. On a light, slow car, of the old Benz type, solids may safely be used; on a light, fast car the mechanism will suffer and the passengers' comfort be affected. With a heavy car the need for solids becomes greater so far as punctures are concerned, but again the demands of the car itself and the passengers assert them.

selves in converse ratio. What really kills the solid tyre, however, is speed, pure and simple, quite apart from the car or the passengers. Beyond a certain maximum rate of progression several factors combine to cause the solid tyre to leave the rim. The heat due to road friction, the pressure arising from the weight of the car, and the combination of centrifugal force with the weight of the tyre itself—much greater than that of a pneumatic—all create expansion and make the tyre rise from its bed and at times fly off bodily. A tendency to creep in the rim is also caused by the non-absorbent qualities of the solid as compared with the pneumatic tyre.

Given a combination of a heavy touring car with moderate speed, the use of solid tyres is practicable; and with a very heavy car, but of low speed, they may also be reasonably employed. But when the speed exceeds twenty miles an hour the solid tyre is inadvisable for more reasons than one, whatever the weight of the vehicle itself.

Of late a tendency has declared itself to effect a compromise on large cars of fair speed by fitting solid tyres to the driving wheels and pneumatics to the front. This method ensures facility of steering, and immunity from road shocks to the engine, and by the aid of long French springs the comfort of the passengers may be preserved, provided that the car is 'nursed' over specially rough surfaces. Even this compromise, however, has its limitations, and does not appear desirable for high-powered cars, unless the power is only used to the full on up gradients and considerably throttled down on level roads.

The types of solid tyre in use are not numerous. Perhaps the best known is the Clincher. The Sirdar and Capon Heaton are also favourably known. A tyre that has also been tried by a few British automobilists is the Falconnet (fig. 20), which is provided with a core of spongy rubber, and is thus somewhat less harsh than the entirely solid patterns. Experience



Fig. 20

has shown, however, that the security of this tyre at speeds in excess of sixteen miles an hour is a doubtful quantity. The tyre shows a tendency to become detached from its bolts, and as it is very heavy it is likely to be lifted off by centrifugal force.

In the case of solid tyres the chief essential is that a gap of a quarter of an inch should be left between the ends, to allow of expansion under heat or pressure. If this gap becomes closed in time one end of the tyre should be cut away. If the tyre be a close fit at the outset it will creep on the rim, crack at the sides, and be liable to fly off at any but slow speeds.

CHAPTER XII

STEAM CARS

BY H. WALTER STANER, EDITOR OF 'THE AUTOCAR'

A STEAM car, although driven by a steam engine, really derives its power from heat, but, instead of the combustible or fuel being burned and converted into pressure in the cylinder of the engine, as in the internal combustion engine of the petrol car, it is burned under a boiler. The expansive or elastic force of the steam pressure generated by the heat of the fire in its turn drives the engine, which gives the car its motion. The heat energy of the fuel is released by combustion; this heat is used to generate steam in the boiler, and the energy of the steam is transformed into motion after being admitted into the engine. Thus the three main essentials of the propelling apparatus of a steam car are the fire or burner, the steam boiler or generator, and the engine.

Fuel.—Coal or coke is not used for pleasure cars, as either is too cumbersome and dirty, and the fire requires constant attention, liquid fuel in the form of petroleum (paraffin), or petroleum spirit (petrol or motor spirit), being universally adopted. Although petrol will ignite instantly if a match be applied to it, and paraffin will not, both must be vaporised or transformed into a gas by heat before they can be economically and cleanly used as heating agents. Not only so, but when vaporised, they must be burned mixed with air on the Bunsen principle.

Examples.—An ordinary domestic gaslight is produced by burning gas in air, but the atmospheric or Bunsen burner burns a mixture of gas and air in air.

Petrol Burners.—Assume for a moment that the petrol for the burner has been vaporised (method to be described later) and transformed into gas, which we will for the future call ‘vapour.’ The Locomobile burner (figs. 1 and 2) takes the



Fig. 1.—Plan View of Burner of a Locomobile

form of a shallow circular metal box about one and a quarter inch deep, and of slightly less diameter than the boiler under which it is placed. There are 107 half-inch tubes, which pass through the bottom and top plates of the box. In the top

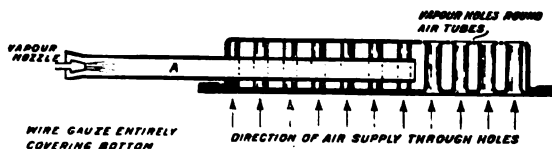


Fig. 2.—Section of Burner

plate twenty small holes are drilled round each of the half-inch tubes, and as the vapour is injected into the box at the pipe A it passes up these small holes round each of the air-tubes, mixed with the air continually sucked in with it as it enters from

the vapour nozzle, and it issues from the twenty small holes round each air-tube, and burns with a solid blue flame above the top plate of the burner, the air for combustion of the mixture (air and vapour) being supplied through the 107 half-inch



M. Serpollet on his first Steam Tricycle (coal-fired) (date 1887)

air-tubes. The tube A at the side of the burner, which is about one inch in diameter, is open at the outer, as well as at the inner end, so that the vapour which is injected into it induces a continual flow of air with it into the burner. The end of the vapour tube which projects into the induction tube A

is called the nozzle or nipple. The burners of the Weston, Milwaukee, and many other American cars are practically similar to the Locomobile, and so is that of the Reading, but in this latter burner the vapour is injected from the centre of the bottom plate, so that the half-inch air-tubes have no break in their disposition, and if the petrol be inadvertently left turned on, there is no chance of it flooding the burner and being ignited when the burner is lighted, as it runs out on to the ground.

Vaporising the Fuel.—The petrol is forced from the petrol tank to the burner by air pressure, a cylindrical vessel is connected with the petrol tank, and it is pumped to about 45 lbs. pressure in the Locomobile and most cars of similar type. The pressure is obtained by means of an ordinary bicycle pump, and it occasionally requires a few strokes of the pump to maintain it as the petrol is used up. An air-pump driven by steam can be fitted to the Locomobile, so that the hand-pump need not be used. To vaporise the liquid, it is passed by means of a tube up through the boiler across the top of it, and down again through another tube, the heat of the boiler being found sufficient to transform the liquid into gas. Thence it passes into the burner. This is the Locomobile arrangement. In the Weston the petrol is pumped through a tube which runs straight across the fire-box, or circular case containing the burner, the heat of the fire vaporising it. In the Reading it is passed in tubes through the boiler once, and also over the fire. It will be seen that these methods, which are mentioned as examples, all require that the burner shall be in operation before the process of vaporising can be commenced, and as the burner can only consume vapour, some additional method is necessary to obtain the initial heat.

Starting the Burner.—The Weston starting apparatus is fed by a separate tube from that which supplies the main burner. Its working is as follows:—The tap A (fig. 3) is opened so that the petrol flows through the tube F, and by opening a small tap B the spirit runs into a little square box, outside the fire-box by the pipe F¹. In this box, G, is a small cup,

and as soon as it is full it runs over and the tap *b* is closed. A match is then applied to a hole in the side of the box *c*, and the petrol in the small cup lighted; it burns under a tube of Γ shape filled with copper borings and heats it and them. This Γ has a tap *c* to it, so that petrol can be injected through it, and when it is heated the petrol, as it percolates through the hot copper borings, is vaporised. As soon as the petrol in the cup is nearly burnt out, the tap *c* is turned, which admits petrol from the pipe *f* into the Γ tube burner above the cup. The flame of the petrol left in the cup lights this 'pilot burner,' and it projects its flame on to the vaporising tube across the fire-box, which supplies petrol to the main burner. When this is believed to be heated sufficiently to vaporise the petrol it can be tested by turning the tap *d*,

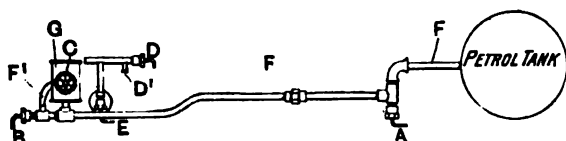


Fig. 3.—The Weston Apparatus for Starting the Burner

when, if the fuel is not vaporised, liquid will issue from the tap *d*¹, and a minute or two longer must elapse before the main burner can be started. As soon as gas is found to issue from *d*¹, *e* is slowly opened, and this admits the vapour into the main burner. It issues into the fire-box, and is ignited by the pilot light. As the heat increases the petrol tube across the fire-box becomes sufficiently hot to vaporise the full supply of fuel, and steam is raised. The pilot light burns continuously, so that when running down-hill or when leaving the car, the main burner can be turned right out; as the pilot light is always burning the burner can be relighted instantly as soon as petrol is turned on again. In the Locomobile the initial heat is usually obtained by a **U** tube, which is separated from the car, and has to be heated in a fire or gas flame. It is then put into the fire-box and

screwed up to the petrol pipes so that the petrol passes through it to vaporise it before it is admitted to the burner. The burner is then lighted, and as soon as the boiler becomes hot enough to vaporise the petrol, which, it will be remembered, is passed through it, the firing iron, as the U tube is called, can be disconnected. This arrangement can now be dispensed with, and in place of it a small Bunsen burner is placed at the side of the fire-box, playing on a coiled tube, through which the petrol passes on its way to the burner. When this coil is heated the small starting burner, which is on a hinge, is turned away from it, but acts as a pilot light, so that the main burner can be almost turned out when stopping or running down hill.

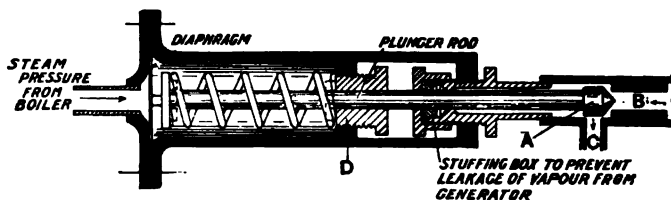


Fig. 4.—Automatic Fire Regulator

The Automatic Fire Regulator.—Many steam vehicles are fitted with an automatic fire regulator, of which the Kelly fitted to the Milwaukee is taken as an example, and it is the same in principle as most others. Fig. 4 is a section of the device. A diaphragm or circular plate is pressed by the steam from the boiler, and as the pressure rises the diaphragm is, so to speak, bulged. In its turn it pushes the plunger rod, which has a conical head A, forward, so that it closes or partially closes the end of the tube B, through which the vapour passes into the tube C on the way to the burner. When there is no pressure in the boiler the coil spring round the plunger rod holds it back, so that the orifice closed by A is fully opened and the vapour passes freely into C and on to the burner. As steam pressure rises the diaphragm is gradually bulged, so that A

commences to close B, and at a predetermined pressure, obtained by adjusting the screw D, it closes B entirely, which only commences to open again as pressure falls. When no constantly burning pilot light is used, there is a small groove cut in the opening B, so that A never completely closes it, and enough vapour is admitted to keep the main burner just alight. In some cars no automatic regulator is used, the fire being controlled entirely by the driver from the seat. It should be understood that although the automatic regulator prevents vapour passing to the burner when a maximum predetermined pressure of steam in the boiler is reached, there is always a tap in reach of the driver which enables him to turn off the supply of fuel at any time.

Paraffin Burners.—For burning paraffin instead of petrol, burners of a somewhat different description are employed, as paraffin requires more heat to vaporise it sufficiently, and when vaporised a larger supply of air is necessary for complete combustion. If these conditions are not obtained, a paraffin burner will smoke and give off insufficient heat. Clarkson's paraffin burner is shown (figs. 5 and 5A). In this the paraffin is forced by air pressure through the vaporiser, which takes the form of a coiled pipe above the flame of the burner. It then passes through the vapour pipe to the jet nozzle, and air is admitted by the door of the mouthpiece, and mixes with the paraffin vapour, which rushes along the inducing-tube and issues from the circular opening below the cap, where it ignites so that a spreading ring of flame is formed, which jets out all round the coiled ring of nickel wire shown in the figure; this and the shape of the circular trough tend to spread the flame, so that it completely covers the bottom of the boiler. The intensity of the fire is regulated by a control lever connected to a handle by the side of the seat, and it will be seen by examining the connections at the bottom of fig. 5 that the needle which increases or decreases the size of the hole of the jet nozzle, by which the vapour enters from the vapour-pipe into the inducing-tube, also proportionately raises or lowers the cap, so that the

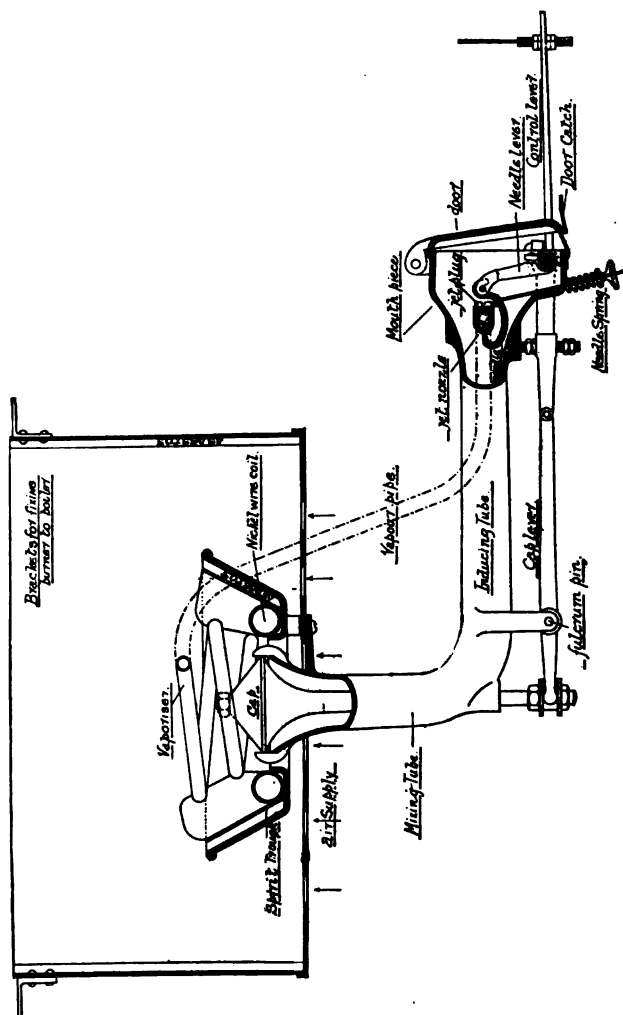


Fig. 5.—Section of Paraffin Burner

opening of the burner itself around the cap is proportionately adjusted in size. Air is supplied by suitable holes in the bottom of the fire-box. To obtain the initial heat, methylated spirit is poured into the circular trough and lighted, thus heating the vaporiser, or when gas is laid on in the stable a flexible tube and gas-jet can be used. The primary reason that the vapour

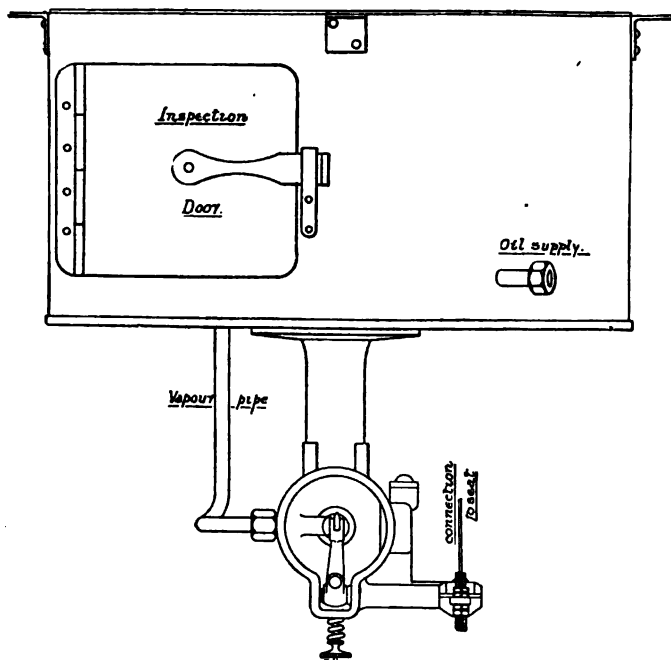


Fig. 5A.—Kerosene Burner (end view)

from the jet nozzle flows up the inducing-tube is because the heat of the fire-box induces a constant inward current of air through the open door of the mouth-piece. No automatic regulator is fitted to this burner, which is in the usual way controlled entirely from the seat, but the makers have designed a special form of diaphragm regulator, which is sometimes used,

and when the burner is applied to a flash boiler, a regulator is employed, which is called the thermo regulator, by which the supply of vapour to the burner is automatically controlled by the temperature of the superheated steam. For explanations of 'Flash boiler' and 'Superheat,' see 'Boilers.'

The Syndicate vaporiser is an arrangement which permits paraffin to be burned in petrol burners of the Locomobile type. It consists of a vaporising coil heated by a suitable wick lamp, and to ensure a sufficient supply of air being mixed with the vapour a small jet of steam blows into the burner from the boiler by the side of the vapour nozzle, and so sucks sufficient air into a type of burner which would not otherwise supply enough for satisfactorily burning paraffin vapour. The arrangement was described and illustrated in 'The Autocar,' of January 18th, 1902.

The Serpollet burner shown in fig. 9 has a number of small atmospheric burners, and the paraffin is vaporised by being pumped in a tube across the fire-box before entering the burners. The initial heat is obtained by a gas-flame, or by burning alcohol in a tray under the vaporising tube. The burners are concentric; the vapour passes up a central tube surrounded by two air-tubes, and the suction of the vapour draws air up these, and it mixes with this air before burning.

The Boiler.—We have seen how the mission of the burner is to supply heat to the boiler, and how that heat is generated and controlled; the next step is to consider the generation of steam in the boiler.

The duty of the boiler is to supply high-pressure steam to the engine. Steam is the gas which water gives off at boiling point, 212° Fahr. High-pressure steam is steam which is confined in a space smaller than that which it would occupy at atmospheric pressure. The smaller the space in proportion to the volume of steam, the greater the pressure. Steam so confined has immense elastic and expansive force, and the boiler and burner are so proportioned that when the pressure of steam is once obtained, the continual generation of it is so

rapid that, although the engine is using it up all the time, pressure is maintained.

Fig. 6 is a photograph of a Locomobile boiler, and fig. 7 shows it partly in section. The boiler is a cylindrical vessel or drum, which should be kept rather more than half filled with water. Through the boiler some three hundred half-inch



Fig. 6.—Vertical Multitubular Boiler

copper tubes run, so that heat from the burner, after heating the bottom of the boiler, passes up these tubes, heating the water in the boiler. In the section it will be seen that the barrel of the boiler is strengthened by winding with piano wire, which is closely wound around the boiler in the same way that a gun is wire-wound. The rough coating of asbestos, or lagging, as it is called, is held to the boiler by thin metal bands.

Its mission is to, as far as possible, prevent the escape of heat, as any loss of heat means that more fuel must be burned to maintain steam.

As the heat passes up the boiler tubes, after heating the bottom of the boiler, the water is heated and boiled, and the steam rises, filling the space between the water-level and the top of the boiler. This space is very much less than the steam would naturally occupy; and, consequently, pressure soon becomes high. The heat from the fire in the boiler tubes not

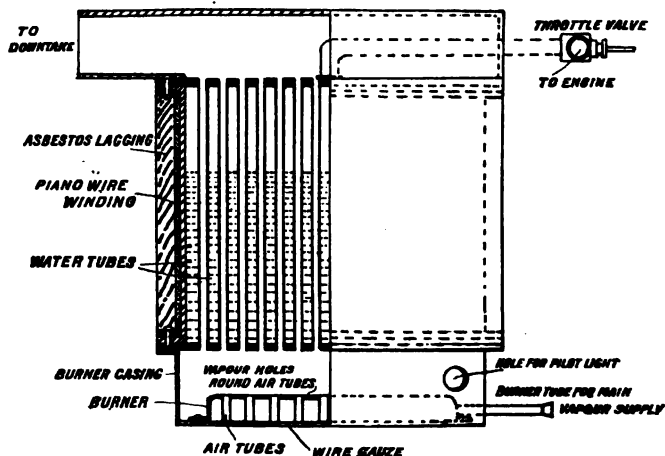


Fig. 7.—Locomobile Boiler with Main Burner in Position

only boils the water around the portion of each tube surrounded by water, but in the upper part its heat tends to dry the steam and keep it from being too wet for satisfactory use in the engine.

The hot gases then pass into a box on the top of the boiler, called the 'smoke-box,' and thence into the down-take, or chimney projecting below the car. The steam from the boiler passes along the pipe to the throttle-valve to engine, the handle of which is by the side of the driver, and as this throttle

is open or shut, steam is admitted or shut off from the engine. The type of boiler we have been describing is fitted to nearly all the smaller and lighter steam carriages, though in the majority of cases steel enters more largely into the construction of the boiler, so that the wire winding is not used.

Boilers with tubes surrounded by water, up which the heat of combustion passes, are known as fire-tube boilers, and are the same in principle as those used on a railway locomotive, though in the latter case the boiler is horizontal, instead of vertical. There is another type of boiler which is largely used on steam lorries and other heavy steam automobiles, which is known as the water-tube type. In this the water is contained in tubes, which the fire surrounds—the exact opposite to the arrangement in the fire-tube boiler.

Fig. 8 is a section of the Toledo boiler, which is a combination of the two types, as an internal chamber is surrounded by water and filled with heat from the burner, but to increase the heating surface a coil of spiral tube is introduced, starting near the bottom of the water, and passing up into the steam space. This induces a very violent circulation of the water, and, although only one coil is shown, eight are actually used, so that the central vessel of the boiler is almost filled with these coils. All boilers are fitted with an automatic safety valve, which releases surplus steam long before the pressure can become dangerously high. The way in which the boilers are supplied with water will be dealt with later.

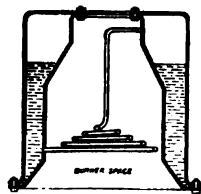


Fig. 8.—Section of Toledo Boiler

The Flash Boiler.—All fire-tube and water-tube boilers carry a considerable quantity of water, but the flash generator is not a boiler at all in the ordinary sense of the word, and contains practically no water. So far as steam generation is concerned, the principle of the flash boiler may be likened to dropping water on a red-hot iron. A small stream of water is

pumped through a coil of tubing, and this tubing is heated to an intense heat by the burners, so that almost as soon as the water enters it, it is 'flashed' into steam—that is to say, the process of boiling and steam generation is all gone through in an instant, and the water which enters the coil of tubing at the bottom issues from the top of the coil as high-pressure superheated steam. This process goes on continually as long as the water is pumped into the coil, as its quantity is always small compared with the length of heated tube.

Figs. 9 and 10 illustrate the Serpollet generator and burner, the latter being dealt with under 'Burners.' The generator

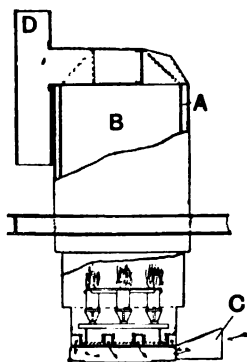


Fig. 9.—The Serpollet Generator with burners below

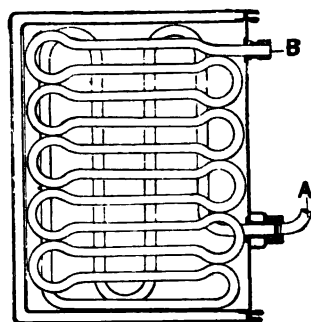


Fig. 10.—Plan of Serpollet Generator, showing arrangement of coils

consists of a box with an outer and inner metal skin packed with asbestos to retain heat. Coils of round nickel steel tube are passed through the boiler, and fig. 10 is a plan of one of these coils. The coils are placed one above the other in varying numbers, according to the power of the engine they are required to drive. They are connected to each other by U tubes, these junctions being outside the burner space, so that they do not get the direct heat of the fire upon them. It will be understood that these coils are arranged like shelves inside the generator case A (fig. 9) in the space B, with the

burners giving off their heat below. The burners quickly bring the coils to a red heat, and a small stream of water is pumped into A (fig. 10), and almost instantly converted into steam. It passes right through the coil, issues at B into the next coil above, and so on to the engine. The upper coil superheats the steam—that is to say, it makes it very much hotter than it would be in either of the types of boilers we have previously described—as after being converted into high-pressure steam in the lower parts of the coils, it is still subjected to great heat in the upper lengths of the coil before it passes to the engine. The expansive force of the steam is considerably increased by this superheating, and not only so, but it is very different from the steam from a fire-tube or water-tube boiler, being much drier, as well as hotter. C (fig. 9) indicates the air-inlet to burner box, and the arrows show the direction of the air currents. D is the chimney.

Pumps.—When steam is up, and the burner in full operation, the water in the boiler is quickly evaporated, and the renewal of the supply is performed by pump. The pump is usually driven off the cross-head, a part of the engine which has a constant up-and-down motion. On most of the smaller cars the water supply is carried in a horseshoe-shaped tank at the back, which half encircles the boiler. In the Serpollet the water-tank takes the place of the motor bonnet of a petrol car.

The pump, fig. 11, has a tightly fitting plunger, which is pulled up and pushed down by the engine. As it makes its upward movement it sucks water in on the right, and the flap valve, which only opens in an inward direction, freely admits the water. As the plunger is pushed down it compresses the water, which at once closes the valve on the right and opens the one on the left, forcing the water to the boiler. The valve on the left is opened by the pressure of water from the pump and closed by the pressure of steam on the other side from the boiler as soon as the down-stroke of the pump ceases. Fig. 12 shows the form of pump more commonly employed on steam

cars, which works on exactly the same principle as fig. 11, but, instead of the valves being of the flap or hinged type, they take the form of conical stoppers fitting into conical holes in the inlet and delivery sides of the pump.

Before the water from the pump enters the boiler, it is usually passed through a coil of tube inside the silencer or muffler, which is a cylindrical case, into which the exhaust steam from the engine is passed before escaping into the chimney. The expansion of the steam in the silencer reduces the noise of the exhaust, and the steam with which it is filled heats the coil through which the water from the pump passes to the boiler, so that the water itself is partially heated when

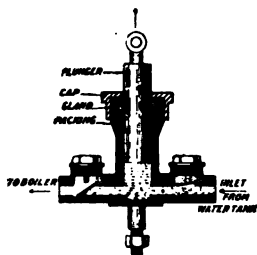


Fig. 11.—Pump with Hinged Valves

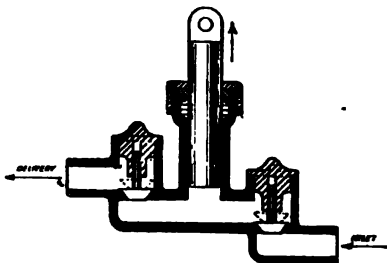


Fig. 12.—Pump with Conical Valves

it enters the boiler. This, of course, means that less heat is required from the burner to keep up the pressure of steam. The pump is at work the whole of the time the engine is running, so when the engine is requiring little steam the pump would overflow the boiler, and to obviate this a two-way cock or tap is interposed between the boiler and the pump, controlled by a handle near the driver's seat, by which he can turn the water from the pump back into the tank. A separate hand pump is fitted for filling the boiler for starting, or at any time when it requires more water when the engine is not running, but on the Locomobile a steam pump is now provided so that steam once 'up' hand pumping need not be resorted to.

We have already shown that in most cars the forcing of the petrol supply to the burner does not require a constantly acting pump, as an air-tank occasionally pumped up by hand provides enough pressure to force the petrol through the vaporiser to the burner, but in the Serpollet the paraffin (which is under air pressure) is also pumped to the burner as well as the water to the generator. The arrangement is shown at fig. 13. It has been found that six parts of water require one part of paraffin to vaporise them in the Serpollet. The oil pump *o* is smaller than the water pump *w*, and both are connected by links *o'*



A 12 h.-p. Serpollet Touring Car (date 1901)

and *w'* to the lever *L*, which hinges on the fulcrum *D*. The lever *L* is moved up and down by the link *L'*, which is connected to the arm *E*. On the arm *E* is a roller *R*, which is forced up and down by eccentric discs or cams *C* on the shaft *A*, which is rotated from the engine by the toothed or cogged wheel *B*. The result is that, as the lever *L* is hinged at *D*, its up and down motion is greater at *w'* than at *o'*, so that the water pump *w* always has a longer stroke than the oil pump *o*.

When more steam is required in the Serpollet, it simply means that more water must be forced into the heated generator

coils by the water pump. At the same time the greater supply of water requires a larger supply of oil to the burner to keep the coils hot enough to evaporate it, and the stroke or up-and-down motion of the lever *L* can be varied by shifting the shaft

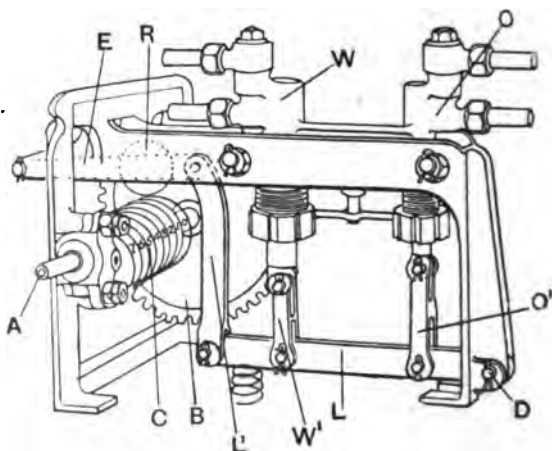


Fig. 13.—The Serpollet Water and Oil Pumps

it sideways, so that cams of varying degrees of eccentricity can be brought under the roller *R*, and its motion increased or decreased as required. As the two pumps are both connected to the lever *L*, it will be seen that whether they are giving full supply or anything below it the proportion of six parts of water to one of oil will always be maintained. On some Serpollet cars the pumps are horizontal instead of vertical, but they operate in a precisely similar manner.



Fig. 13A.—Example of Cams of Different Throws

Fig. 13A shows three cams in a row. These cams are eccentric discs fixed on a revolving shaft, and as the faces of Nos. 2 and 3 do not project so far from the shaft as 1, if the roller *R* be introduced against the face of 3, for instance, it will be moved up and down less than if it were bearing against the

face of No. 1, so that all the driver has to do when he wishes to increase or decrease the steam supply to his engine is to shift a lever by the seat, which moves the shaft, on which there are eight cams (fig. 13) of varying eccentricity, when the stroke of his pump will be proportionately altered. It should be added that the roller R is kept down on to the cams by a spring, which will be noticed under the lever L (fig. 13).

Water Gauges.—All fire-tube and water-tube boilers, i.e. all boilers in which any appreciable quantity of water is carried, are fitted with a water gauge, as they are not sufficiently thick to resist damage from burning should the water level be allowed to become so low that the tubes and tube plate become unduly heated. A water gauge is to all intents and purposes a glass window in the boiler. It takes the form of two taps, one below the water level, and the other above. These two taps are connected by a glass tube, provision being made to prevent leakage where the glass joins the taps. In the steam cars, as the boiler is out of sight of the driver, under the seat, tubes are provided so that the water gauge can be placed nearer to him, and a looking-glass is fitted on the dashboard, reflecting the gauge to the driver's eye.

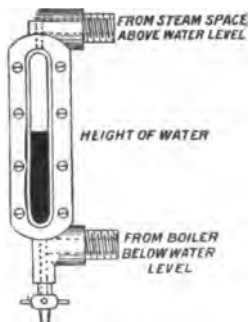
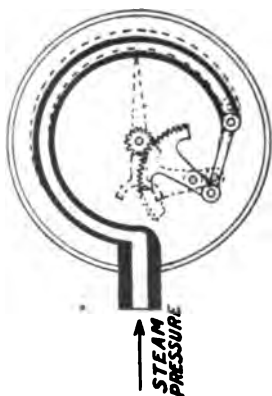


Fig. 14 —The Klinger Water Gauge

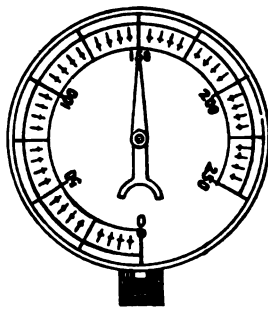
The Klinger gauge (fig. 14) is a great improvement on the ordinary type, as it is provided with a glass window of prismatic section, and the result is that the water is shown black, and its height is much more easily read than with the ordinary glass gauge-tube. Should the driver have reason to doubt the accuracy of his gauge, he can test it by opening the tap at the bottom. All water gauges have a similar tap.

Pressure Gauges.—Pressure of steam in the boiler is expressed in this country in pounds to the square inch, and

a small instrument known as a steam pressure gauge is used for the purpose. This is connected to the boiler by a pipe, and is fixed on the dashboard in front of the driver, and a hand on the dial indicates the steam pressure in the boiler (fig. 15). The interior mechanism of the gauge is extremely simple. It consists in a tube bent in a loop, as shown. One end is open to the steam pressure of the boiler, and the other end is closed, the closed end being attached to a short arm, which moves a rack engaging with a small toothed wheel



Steam pressure Gauge with face removed and Bourdon Tube in section



Steam pressure Gauge, ordinary appearance

Fig. 15.

behind the dial, and so turning the hand on its face. The gauge depends for its working on the fact that a bent tube, when subjected to internal pressure, tends to straighten itself out.

The Engine.—Having seen how the heat is supplied by the burner and steam by the boiler, we turn to the engine. This description of the engine need not be read by the novice unless he likes, as it deals with a portion of the car which is quite automatic, and which is exactly the same in its operation

as the engine of that most reliable automobile—the railway locomotive. Most steam cars have two cylinders, but for the sake of simplicity we will describe a single-cylinder engine, as the principle of working is identical. Fig. 16 shows the cylinder A, in which a piston B is free to move up and down. The steam is admitted alternately at the top and the bottom of the cylinder by means to be described later. To the piston B a piston-rod C is fixed, and it issues through a hole in the bottom of the cylinder. Both the piston B and the hole through which the piston-rod issues from the cylinder are rendered steam-tight by means to be presently described. The piston-rod C is attached by a hinged joint D to the connecting rod E, which at the other end encircles the crank-pin F of the crank G, which moves, as shown by the arrow and dotted line, in a circle of which H is the centre. We will assume that steam is admitted to the top of the cylinder A. It blows the piston B downwards, which in its turn depresses the piston-rod C, and, as this is connected to crank G by the connecting rod E, the rotation of the crank is started. When B gets to the bottom of the cylinder, the steam supply on the top of it is stopped, and steam is admitted underneath the piston, so that it is blown upward from the underside, and the crank is pulled up. As B ascends it expels the steam from the cylinder which had driven it on its downward stroke. This action is kept up as long as the engine is at work, and by the interposition of the connecting rod and crank, the reciprocating or,

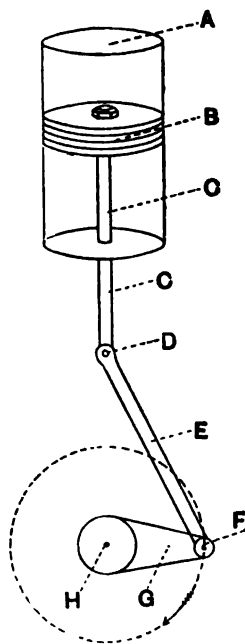


Fig. 16

to-and-fro motion of the piston is transformed into rotary motion.

The Slide Valve.—The admission of the steam at alternate ends of the cylinder, and its outlet after it has forced the piston down or up, is controlled by the slide valve, which is worked by the crank-shaft of the engine. Figs. 17 to 20 show the slide valve and piston in different positions, and figs. 21 and 22 give details of the steam ports, exhaust port, and slide valve. Steam ports SP, or openings, are made at the top and bottom of the cylinder, fig. 17, and these are shown in plan at fig. 21. Between them is an opening EP, the exhaust port and the slide valve SV, which from fig. 22 it will be seen

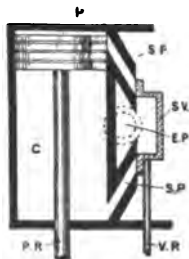


Fig. 17.—Piston at top, valve closed, just about to open

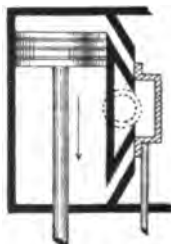


Fig. 18.—Valve open a little; piston descending

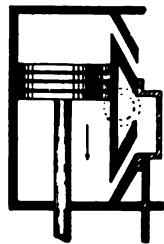


Fig. 19.—Valve full open

is a hollow box, alternately covers and uncovers the steam ports for admitting steam to the piston. While it is doing that for one end of the cylinder it is connecting the other steam port with the exhaust port, so that the steam, after it has done its work, can escape freely.

We will assume that the engine is running, and at fig. 17 the piston P in the cylinder C has reached the top of its stroke. At this moment the top steam port is closed by the edge of the slide valve, but as the piston commences to descend on its return stroke, the slide valve has also moved downward, so that the steam is admitted to the top of the piston and forces it downward, as shown in fig. 18.

In fig. 19 the piston has descended further, and the top steam port is fully open to it, but as the slide valve has also descended further, the bottom steam port is open, and the steam which had forced the piston upward in the previous stroke is now, having done its work, pushed out by the descending piston through the bottom steam port into the box portion of the slide valve, and as it will be seen that this is also open to the exhaust port, the steam passes away to the chimney.

In fig. 20 the piston has reached the bottom of its stroke, and is just commencing to ascend, steam being gradually admitted to the bottom steam port while the top steam port is

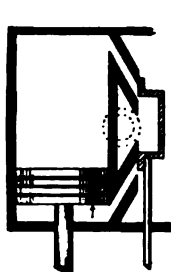


Fig. 20.—Valve open to bottom of piston ; piston ascending

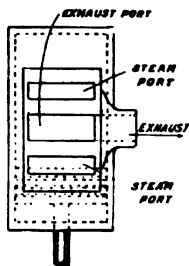


Fig. 21.—View of Valve face and exhaust outlet at side.



Fig. 22.—Plan View of Slide Valve

being opened by the upward movement of the slide valve, so that the steam on the top of the piston can escape into the exhaust. These actions are continued while the engine runs, and as we have already seen how the up-and-down motion of the piston turns the crank, it is necessary for us to find out how the slide valve is moved backward and forward, so as to perform the operations we have described at the proper time with relation to the piston.

Figs 23, 24, and 25, although mainly for another purpose, will also show how the slide valve is operated. Fig. 25 shows the position of the valve when the engine is running forward. Two eccentrics are keyed to the crank-shaft. These two

eccentrics $F E$ and $B E$ are circular discs; they are not, however, fixed to the shaft at their centres, but eccentrically. As the shaft revolves, they have an up-and-down motion, practically the same as if they were cranks. A ring encircles each eccentric, so that the eccentric itself is free to revolve in the ring. To the ring the eccentric rods F and B are fixed. At the other end the eccentric rods are connected on working joints to a curved link. In the curved link is a block B , which has a free sliding fit, and this is connected to the slide valve rod $V R$ in figs. 17 and 22, and plainly shown in figs. 23, 24,

Diagrams for link motion

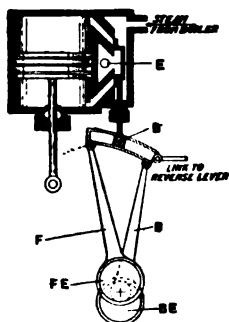


Fig. 23.—Mid Gear : no steam

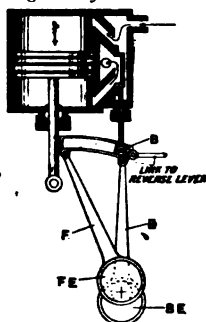


Fig. 24.—Backward Gear : steam at top

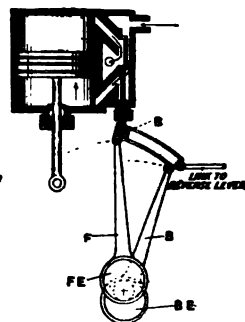


Fig. 25.—Forward Gear : steam at bottom

and 25. As the engine revolves the eccentric gives an up-and-down motion to the rods which are hinged to the link. If we look at fig. 25 it will be seen that the forward eccentric rod is nearer to the slide valve rod than the backward eccentric, and this results in an up-and-down motion of the slide valve being produced by the forward eccentric $F E$, as the backward eccentric $B E$ only forces the right-hand end of the link up and down, and does not drive the slide valve. In fig. 23 we see that by the link connected to the reverse lever by the side of the driver the curved link connecting the two eccentric rods to the slide valve has been so moved that the slide valve

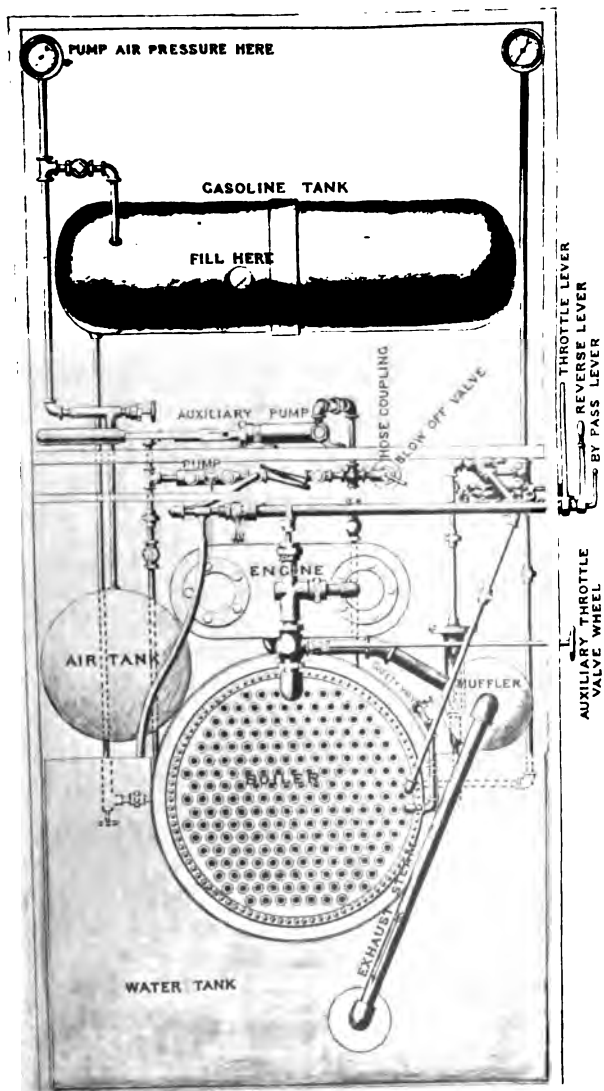
rod is placed in the middle of the link. As the engine revolves the eccentrics simply push each end of the link up and down alternately, giving practically no motion to the slide valve, but by moving the reversing handle so that the curved link takes position somewhere between those shown on fig. 25 and fig. 23, the travel or distance which the slide valve moves up and down is reduced, so that the steam is cut off from the piston before the end of its stroke. This process is known as 'notching up,' and it simply means that the steam, instead of being admitted to the piston almost to the end of each stroke, is cut off before the stroke is completed, the expansion of the steam being sufficient to finish the working stroke. This results in a distinct economy in steam, and is one of the first things which a driver of a steam car should learn to do, for it is often unnecessary when running fast on the level or down slight slopes to drive with the steam admitted right to the end of each stroke. This results in economising the steam, which in its turn means that less fuel is used. The backward and forward eccentrics are so set with relation to the crank that the steam is admitted and released at the proper time. When running forward, the forward eccentric does all the work of moving the slide valve up and down, and when running backward the backward eccentric performs it. In other words, the eccentric rod nearest the slide valve rod is the one which works the eccentric, and when we get into the position of 'mid gear' (fig. 23) no steam is admitted at all, as both eccentrics are working the link up and down, but not moving the valve, the block B occupying the same relation to the curved link that the boy does to a see-saw when he stands in the middle of it. The box on the side of the cylinders, in which the slide valve works, is known as the 'steam chest.' The arrows show the passage of the steam from the boiler into the cylinder and out of it, E, the exhaust outlet, being marked for clearness in fig. 23. Although we have spoken throughout as if the eccentrics were so set in relation to the crank, and the slide valve so proportioned that the steam was all pushed out

by the piston when exhausting, it should be understood that the exhaust port is closed just before the piston reaches the end of each stroke, so that a small quantity of steam is what is called 'trapped' in the cylinder. This serves as a cushion, and prevents the reversal of the direction of the piston being accompanied by any shock. We do not go into the mysteries of 'lap and lead,' as they are matters which the manufacturers of steam engines satisfactorily settled long ago, and the automobilist need not trouble himself concerning them.

Anyone who is absolutely unacquainted with link motion and steam engines generally should, if he wishes to get an insight into the working of an engine, spend a quarter of an hour examining a small model steam engine. He will learn more of its working—which is very simple in itself, though laborious to plainly describe—in five minutes than he can from as many hours of reading. It should be understood, with regard to figs. 23, 24, and 25, that the link motion is shown at right angles to its true position, as, while we have an end view of the cylinders and slide valve, we have a side view of the links and eccentric rods, this distortion occurring merely for the sake of clearness. Nor are the eccentrics fixed quite at right angles to the crank, but to explain this would occupy more space than we have at our command.

The Reading Engine.—Nearly all the small steam cars are driven by two-cylinder engines, the only exception being the Reading, in which a four-cylinder engine is used. This is a most ingenious engine, which we regret space does not permit us to describe in detail. It has no slide valves, and the steam is admitted to and released from each cylinder by a single rotary valve, this one valve on the top of the four cylinders serving them all, and also providing for reversing. This engine was fully described in 'The Autocar' of April 20th, 1901, and September 21st, 1901.

Compound Engines.—The engine driving the House car is a two-cylinder one, but it is so arranged that one cylinder receives high-pressure steam from the boiler, and, instead of



Plan of a Locomobile Car, showing position of Boiler, Engine, Tanks, &c.

the exhaust being passed away into the chimney, it is turned into the second cylinder and drives the piston in it before being released. The high-pressure cylinder is smaller in diameter than the low-pressure cylinder, which is of such diameter that the power from the low-pressure cylinder is practically equal to that of the smaller high-pressure cylinder. For starting purposes, or when special effort is required, the driver can turn high-pressure steam into both cylinders. The idea of the compound engine is economy of the steam consumption, as more work is got out of the steam before its final release. Linking up, or using the steam expansively in an ordinary or simple engine, is done with the same end in view.

The Serpollet Engine.—This engine is designed to use superheated steam, and is entirely different from the ordinary steam engines which we have just described.

The Serpollet engine is practically an adaptation of the internal combustion engine to fit it for using superheated steam. Fig. 26 is a side view of the engine, half of it being shown in section. It has four cylinders and a two-throw crank, but only two cylinders A A are shown, as the other two are immediately behind them. It is a single-acting engine, that is to say, each piston is forced towards the crank by the steam, but it is not forced back. Instead of slide valves, mushroom valves (see chapter on Petrol Engines) are used. H shows one of these valves in section, the steam inlet valve. The exhaust valve to each cylinder is exactly the same as H, but as it is behind it cannot be shown in the drawing. The exhaust steam passes through J and out at J¹. The valve H is kept closed by a spiral spring, which encircles its stem, and H is opened and closed by the to-and-fro motion of F through G, F being moved by the cam E on the cam-shaft D, which is driven by a toothed wheel on cam-shaft C, working into a similar toothed wheel on crank-shaft N. The exhaust valve is similarly operated, and the engine is reversed by sliding another pair of cams under the rollers working the valves. A piston B

drives the crank direct through the connecting rod *K*, exactly the same as in a petrol engine. *L* is the flywheel, and *M* a tap for letting dirty lubricating oil out of the crank chamber. Each of the four cylinders works in a precisely similar way to the one described. In some engines the valves are parallel with the cylinders instead of slightly inclined as shown in fig. 26.

Piston-rings.—These scarcely require description, as they are the same in principle as those used in petrol motors, and by turning to the chapter dealing with these the reader will be

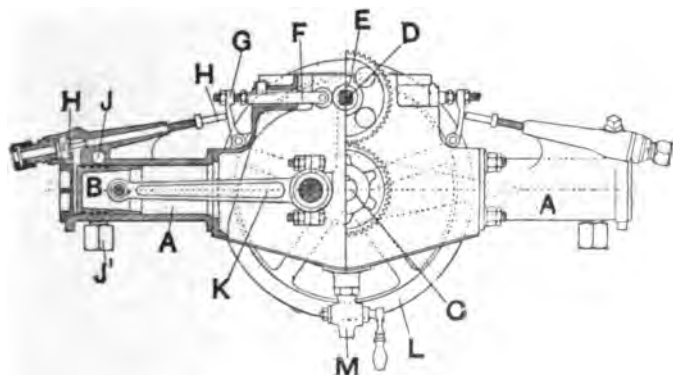


Fig. 26.—The Serpollet Engine

able to find out how the piston, which must be a free sliding fit in the cylinder, is also pressure-tight.

Stuffing Boxes.—As the piston-rod issues from the bottom of the cylinder it is necessary that this should also be a free sliding fit, and at the same time steam-tight. These ends are attained by having a circular cavity, into which packing is inserted and held firmly by a screw ring or gland, and a lock-nut. Two forms of stuffing-box are shown in figs. 27 and 28. The packing usually consists of some substance in which asbestos and graphite are mainly used.

Condensers.—In damp weather, when using a full supply of

steam, the exhaust from the engine shows, just as on the same sort of day the steam from horses becomes visible, and to obviate this condensers are used. For the majority of cars the Clarkson condenser is in use. This is described as a 'radiator' in the chapter dealing with internal combustion engines, and needs no further description here, except to say that, instead of water being passed through it, the exhaust steam from the engine takes its place and issues from the bottom of the condenser almost invisibly in a small stream of hot water. In the Serpollet, House, and other cars different forms of condensers are used, but the action is the same. They consist of long ranges of pipes exposed to the air, through which the steam is passed and so condensed into water. Some of the light steam

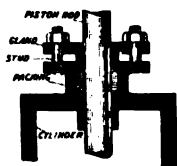


Fig. 27. Stuffing Box with studs and flange

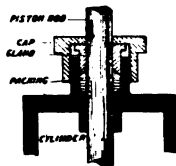


Fig. 28. — Stuffing Box with screwed cap

cars are fitted not only with the Clarkson condenser, but also with an oil separator and a water filter, as the steam, instead of being dropped on the road after condensation into water, is pumped back into the tank and used over again. To cleanse it from the oil, which would otherwise damage the boiler, the oil separator and the filter relieve it of all injurious impurities before it reaches the tank. By this means a car can be driven at least double as far without renewing water, that is to say, from fifty to sixty miles, instead of twenty to twenty-five. These remarks apply to cars of the Locomobile type, with the usual tanks, but by having a larger water tank and an extra petrol tank, they can be run greater distances without replenishment.

A convenient fitting is now applied to the Weston car in

the form of a steam 'water-lifter.' When the tank requires replenishment, the water has to be poured in from a bucket or can, unless a hose be available, but the water-lifter does this work by steam from the boiler, and completely fills the tank in five minutes, and heats the water to 140° F. in so doing.

The Car.—We do not deal here with the car itself, nor with the transmission, as the latter has a special chapter reserved to it, and the cars, beyond their light tubular framing and generally light build and very simple transmission, are, broadly speaking, similar to the petrol carriages. It should be understood that the makes we have mentioned are cited as examples. No attempt has been made to mention numerous interesting types which do not differ in their main essentials from the cars we have described. The novice who first examines a steam car may possibly be somewhat appalled at its apparent complication, but if he examines the pipes and connections generally, and ascertains their exact mission, he will soon see that the apparently bewildering multiplicity of parts is not very formidable after all. There is no mystery whatever about the mechanism; it merely needs a short study to be easily appreciated.

As compared with a petrol car, the main advantages of a steam vehicle may be summarised in its quietness and evenness of running, ease of starting and restarting, and the great range in the power of the engine, which stops and starts with the car, and can also when necessary be used as a very powerful brake. Steam cars do not put such hard work on the tyres as those driven by petrol, as the engine power is softer in action, and nearly all of the steam cars are lighter in weight than the others. The transmission of the power from the engine to the road wheels is much simpler than it is in the case of the petrol car, but the boiler, burner, &c. make up for this simplicity. It needs more attention on the road in the way of looking after the water level and the steam pressure, but this soon becomes automatic, and is quite as unconsciously performed as the

balancing a bicycle after one has once learned to ride. The cause of any stoppage can usually be more easily traced than with a petrol engine. Stops for fuel and water are more numerous, and the fuel consumption greater (about one gallon of petrol every twelve miles on average roads).

The Art of Driving.—Almost anyone can drive a steam car in a few minutes, but it requires experience to get the best results. The great art of driving is always to have sufficient steam in hand to get up any hills that may be met with on the road, and at the same time to keep down the consumption of fuel and water to



The De Dion Steam Vehicle driven by the Marquis and the Count de Chasseloup-Laubat. (See Chapter I.)

the lowest possible limits. Considerable space might be devoted to discussing the niceties of the art of driving a steam carriage, but they may be summarised as consisting in the maintenance of an even steam pressure and mean water level on all conditions of roads, with a minimum consumption of fuel and water. If the owner takes the trouble thoroughly to understand his car and its mechanism first, and then bears this rule in mind, he will soon acquire the art, and will learn to take advantage of every variation in the gradient and road surface. Linking up plays a very important part in the economy of fuel, and by

doing this whenever circumstances permit, by cutting down the fire when descending hills, and by using steam with moderation at the foot of a long hill, it is wonderful what can be done. It is also necessary to remember that the best results will be obtained by keeping the boiler fairly full. If the water is allowed to get low, a large supply has to be given to it at one time, and this results in an instant drop of steam pressure. The great thing for the novice to guard against is 'burning the boiler' by allowing it to become nearly empty, so that it gets overheated. Care should also be taken that the engine and all working parts are properly oiled—never allowed to run dry or to be flooded with needless oil. The boiler should be 'blown down' twice a week when the car is in use. When the drive is finished the pressure should be allowed to fall to 50 pounds, and then the blow-off cock or tap opened so that all the water is blown out, and with it all sediment and deposit which would otherwise form a coating on the inner surface of the boiler and tubes. This is like the 'fur' in a kettle, and not only reduces the steaming power of the boiler, but also eats away the metal. So long as the boiler is regularly 'blown down' it will not get furred.

Quite apart from questions of economy, the owner who studies his car and endeavours to get the best results out of it will find that his interest in the pastime is greatly increased, as he is provided with an interesting occupation the whole time he is driving, and never for one minute does the way seem long or the driver feel bored. Finally, the driver should always make a point of seeing that everything is in good order, as it should be before he starts out, and he should not leave trifling but necessary adjustments, which might have been seen to before he started, to be performed on the roadside. If he follows this advice he will have a vehicle which is as trustworthy as a railway locomotive, and almost as durable.

CHAPTER XIII

ELECTRIC CARS

BY THE EDITOR OF 'THE AUTOMOTOR'

AN electromobile is a vehicle propelled by one or more electric motors driven by current supplied by accumulators carried on the car itself.

In dealing with the subject it is not proposed to go into detail as regards matters of car-construction, arrangements of gearing, or the other features which every electromobile necessarily possesses in common with other self-propelled vehicles; the intention is to deal mainly with the special features which characterise it, the assumption being made that readers are now familiar with the general mechanical principles involved in all classes of self-propelled vehicles.

An electric vehicle may be regarded as consisting of a body, a running gear, with one or two motors mounted on it and arranged to operate the driving wheels of the vehicle through speed reduction gearing, of a battery of accumulators carried on the car itself, of connections between this battery and the motors, and of a controller, the functions of which will be explained.

It will perhaps be best to deal with the subject in accordance with this general division, and first of all to consider the principles and characteristics of electric motors and accumulators, after that the connection between the two—under which heading the construction of the controller will be discussed, and the general principles will be considered. Then it is proposed to give a cursory description of different types of running gear, illustrated by a couple of actually running electric

vehicles; finally to treat of the ailments and misfortunes to which electromobiles are subject, and the general prospects and position of electromobilism at the present day.

An electric motor is a machine which produces rotary movement owing to the magnetic action caused by an electric current.

Everyone is doubtless familiar with the ordinary magnet, a piece of steel either straight or, more often, shaped like a horseshoe, possessing the property of attracting certain metals which are termed magnetic, or more accurately para-magnetic. Nickel and iron are amongst those which are attracted, but iron is much more powerfully attracted than nickel.

Next to the faculty of attracting iron, the most characteristic property of the ordinary magnet is what is generally known as polarity. Its two opposite ends possess different properties. This is not apparent when a magnet is applied to soft iron, which is unmagnetised, but is obvious when one magnet is applied to another. The ends and poles of the magnets are usually distinguished by being called north and south poles, and designated by the letters N and S. By the north pole of a magnet is generally meant the end which, if the magnet be very freely pivoted or floated on water, will point towards the north. The south pole is the other end. Sticklers for accuracy call these different ends the northward-pointing pole and the southward-pointing pole. We will content ourselves with designating them simply by the letters N and S. If a bar magnet be broken in two, each broken portion also displays polarity. If two magnets be confronted with the N pole of one opposite the S pole of the other, they will attract one another. If the two N poles or the two S poles be brought together, repulsion will result.

The main property of electricity, or, to be more correct, of an electric current, which is of most importance in connection with the production of movement by its means, is its power to produce magnetism.

We do not know precisely what electricity is, and by

implication we do not know precisely what an electric current is, but we have all requisite knowledge about it for practical purposes. An electric current is a something which occurs in a conductor, i.e. a piece of metal when it connects two points between which there is electric pressure. The current may be only momentary, as in the case of Franklin's kite with a wire attached which was sent up into a thundercloud, or when a so-called Leyden jar is discharged; or it may last a little longer, as when we discharge a dry cell. Finally it may last some hours, as in the discharge of an accumulator; but while it lasts its characteristics—the effects it produces—are the same. It heats the metal through which it flows, and it produces magnetism in the neighbourhood. The difference of electric pressure between two points is termed potential difference, and it is measured in 'volts.'

Every conductor opposes a certain amount of resistance to the passage of the electric current. This resistance is measured in what are called 'ohms,' the ohm being a unit of electrical resistance. It is the electrical resistance of a rod of copper of a certain length and thickness when at a certain temperature. The electric pressure or difference of potential which will send a certain amount of current, called an 'ampere,' through a conductor the resistance of which is an ohm, is one volt. It is half the pressure approximately existing between the terminals of an ordinary accumulator, and is about enough to heat half an inch of thin platinum wire red-hot. Volts, amperes, and ohms are all mutually dependent units of measurement—thus, if along any wire, the resistance of which we know to be an ohm, there is flowing one ampere of current, we know that the electric pressure or voltage between the ends of that wire is one volt. If there be a difference of pressure at the ends of the conductor of one volt, and we find that there is half an ampere of current flowing, we know that the resistance is two ohms. If we have a pressure of two volts maintained between two points, and we connect those two points by a wire, and find that two amperes of current flow through

it, we know the resistance of the wire is one ohm. The analogy with the phenomena presented by liquids, such as water moving in pipes, is very close. Voltage corresponds to the pressure or head of water, ohmic resistance to the skin friction between the pipe and the running water, and amperage to the amount of water passing, say, in gallons per minute. Voltage, amperage, and ohmic resistance are measured in practice by special instruments called voltmeters, ammeters and ohmmeters.

The novice is sometimes troubled by having to familiarise himself with the notion that an electric current can flow through, or in, such a solid thing as a copper wire. Some people would perhaps find it easier to understand electric phenomena if conducting wires were made hollow. Persons who take this point of view may, however, console themselves with the reflection that a wire is not as solid as it looks, and also that some of the electric current runs along the outside.

An electric current produces a magnetic condition, generally called a magnetic field, in the neighbourhood of a conductor—say a wire—along which it is passing. If a wire be twisted up into a helix, as at *w* in fig. 1, and if an electric current be led into it through the flexible conductors or brushes *B* and *B'*, it would act in a feeble way like a magnet. If the current be stronger, it will act like a stronger magnet, and it will have one pole near where the current comes in and another pole where the current goes out. If a rod or core of soft iron *c* be slipped inside the coil of wire *w*, and insulated or electrically separated from it, so as to prevent the electric current from passing through it instead of through the wire, the core *c* will become a powerful magnet. As long as the electric current is passing it forms an *electro-magnet*. When the current ceases to flow, the iron will lose its magnetism—that is, provided it is soft. If a core of hard steel be used, it will take some time to become magnetized, but when it is magnetized it will be a permanent magnet. It is in this manner that soft iron and steel differ magnetically. If *N*, in fig. 1, be the north pole of a magnet

(whether the pole of a permanent magnet or of an electro-magnet does not matter) and if the current passes along the wire *w* so as to produce a south pole near the top of *c* slightly below *N*, and if the coil and core be capable of upward movement only, there will be a tendency for *w* and *c* to rise.

If a casting of soft iron or mild steel, shaped like *M* in fig. 2, have an insulated wire *w* wound round it in the manner shown, and a current passed round it in the direction of the

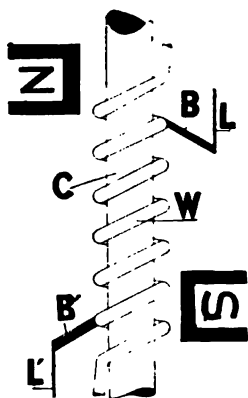


Fig. 1

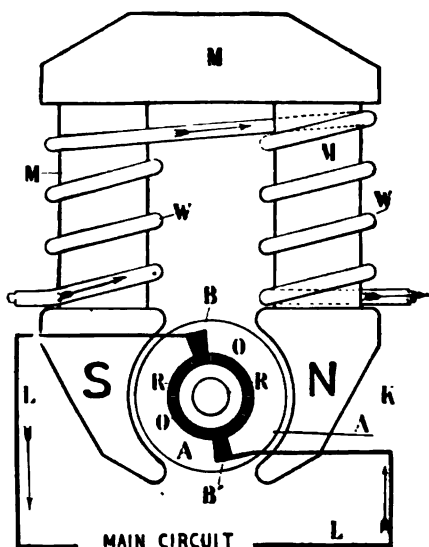


Fig. 2

arrow, an electro-magnet will be produced with powerful poles, capable of strong attraction as at *N* and *S*. It will be understood that the windings are of course merely diagrammatic, many more turns of wire being used in actual practice.

If a soft iron ring, *c*, fig. 3, have a wire *w* continuously wound round it, and the current is supplied to this wire through the flexible brushes *B*, *B'*, from leads *L* and *L'* coming from a battery of accumulators, the ring will become magnetic, and will resemble

two half ring magnets put together, there will be a double pole of one kind where the current enters, and another double pole of the opposite kind where the current goes out. If the brushes be arranged to slip from one coil of the wire *w* to another, then if the whole wire-wound ring *c* be turned round, the magnetic poles will remain constant in space, although the ring turns round. If such a ring be mounted between the poles of such an electro-magnet *M*, as shown in fig. 2, there will be a permanent pull on one of its pairs of poles in one direction and a permanent pull



Fig. 3

on the other pair of poles in the opposite direction. Now the position of these poles in space is permanent, and depends upon the position, as already explained, of the brushes *n* and *n'*. The result is that perpetual rotary pull or *torque* is produced in the ring and it turns round. The amount of torque produced is dependent upon the amount of magnetism present, that is upon the strength of the poles *N* and *S*, and the strength of the poles produced in the ring *c*; and this depends on the strength of the current flowing, and the

number of turns of insulated wire. It will be understood that if the magnet *M*, fig. 2, were a permanent magnet instead of an electro-magnet, movement would still occur, and an electro-magnet can be made much more powerful than a permanent magnet. The power of such a motor may consequently thus be increased.

The ring shown in fig. 3 represents a Gramme ring, which was one of the earliest and simplest forms of *armature*, i.e. revolving portion, employed in electric motors. In practice the current is not brought to it as shown in fig 3, but a device called a commutator, shown at *K*, fig. 2, is employed. The ring is mounted on a spider or on a centre which revolves in suitable bearings. The commutator *K* consists of a ring of conducting segments *R R*, separated by insulating pieces *O O*. Each one of the conducting segments *R R* is joined up by a wire or rod to equidistant portions of the armature winding *w*, so that the current supplied to the commutator by the brushes *B*, *B'* enters the winding *w*, in the same manner as shown in fig. 3.

Fig. 2 shows a simple form of electric motor, of what is called the 'separately excited' type—that is to say, the electro-magnet is rendered magnetic or excited by an electric current proceeding from some separate source of electricity, such as a battery separate from that which supplies the electric current to the rotating part or armature. Fig. 3 represents, as already stated above, the Gramme ring. This is a form of armature which is but little used in electric motors, some form of drum armature being now almost universally adopted. The drum armature is a development of the Siemens shuttle armature, and will be best understood from the inspection of a section of that arrangement, fig. 4. In this section *x* is the spindle of the armature, *c* being the iron core, shown in the rounded *H* section, and *w* the coil of wire covered with insulating material *i*. The whole arrangement is very much longer than it is thick, and really does resemble a shuttle. The two poles are formed by the sides of *H*. Instead

of arranging all the wire in a single winding, we may distribute it over the surface of a soft iron cylinder, connecting it up to the sections of the commutator. This forms a drum armature, and is used in the great majority of electric motors employed on electromobiles. Such drum armatures of course differ in proportions, but the general arrangement is the same.

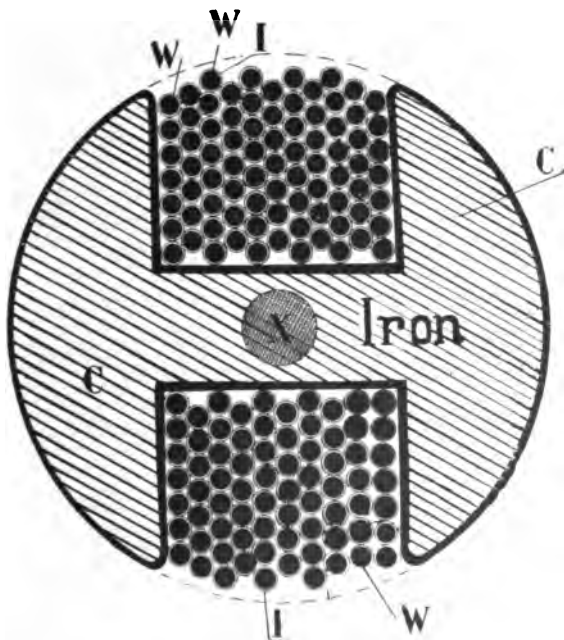


Fig. 4

Figs. 2, 5, and 6 illustrate the three main types of the two-pole electric motors. Fig. 2 shows, as already explained, a two-pole separately excited motor. This may be looked upon as a motor in which the magnet is rendered magnetic by a current from a separate battery (a few accumulator cells usually sufficing for this purpose). To all intents and purposes it may be regarded as if the separately excited

magnet were a permanent hard steel magnet of the same shape.

The two other types of motor are the shunt-wound motor, fig. 5, and the series-wound motor, fig. 6. In the shunt-wound motor the current, which is led by two conductors from opposite ends of the battery of accumulators to the brushes which supply the current to the commutator, and so to the armature, branches off from those brushes and goes round the

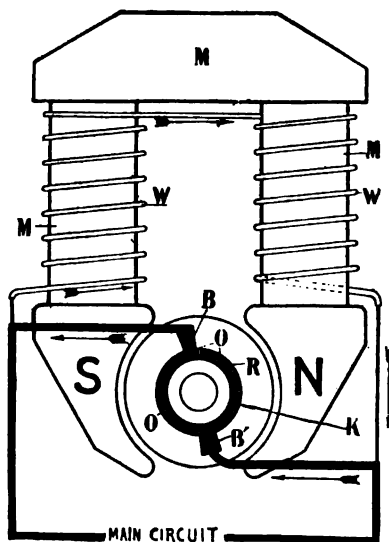


Fig. 5.

coils wound on the field magnet. In the series motor the current traverses the field winding either before or after passing through the armature. There is a fourth variety of motor, known as the compound, in which the field magnet has both series and shunt windings. This type of motor is used in the Krieger cars.

The characteristics of series and shunt motors are different. The shunt motor tends to run at constant speed, no matter

what the load may be, provided the voltage or pressure of the current supplied to it be the same ; and it will consequently try its best to force a car provided with it through mud or uphill at the same pace as it would drive on the flat. The series motor, on the other hand, more or less apportions its speed to the load, and will go slower uphill and faster on the flat. The series motor has this additional advantage compared with the shunt motor, that it produces a greater starting torque or turn-

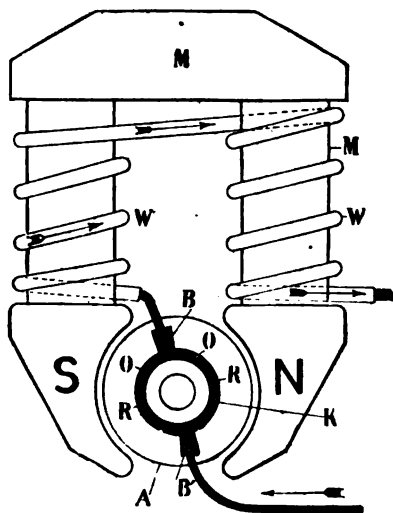


Fig. 6

ing moment—that is to say, series motors are better calculated than shunt motors for starting a car from a state of rest or getting it out of difficulties. Generally speaking, we may say that, for automobile purposes, series motors and separately excited motors, which present some of the characteristics of a series motor, are to be preferred for the propulsion of vehicles.

The majority of motors actually employed in electromobiles have four poles, and the brushes which lead the current to the commutator are usually of carbon, held in special brush-holders

suitably pivoted. This is well illustrated in the case of the Krieger or Postel-Vinay motor, fig. 7, designed by M. Cuènod, which is in general use on the Krieger vehicles, and has in consequence become generally known as the Krieger motor. This motor has four poles with four flat coils, *c, c*. Each of the coils on each of the poles is of a twofold composition, being partially a thick wire winding designed for use as a series winding, and partially a thin wire winding designed for use as a shunt winding; the Krieger vehicle, as we shall subsequently show, using the motors sometimes as series motors, and sometimes as shunt motors, according to the conditions

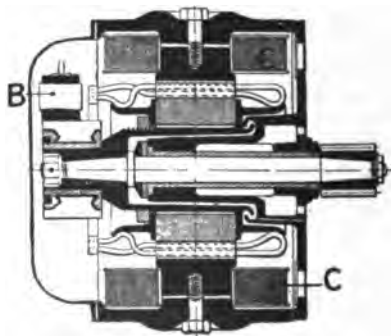


Fig. 7. —Motors of ' Powerful '

of running. The motors, which are pivoted, and swung on springs, are provided with only two brushes, *B*. It might be supposed that, having four poles, four brushes should have been provided, and some of the original four-pole motors were so constructed. It was shown, however, by Mr. Mordey that by connecting the opposite wires on an armature in parallel with one another two brushes only might be employed instead of four. Electrically this is of course the same thing as using four brushes and cross-connecting them.

Other types of motor have also been employed successfully for the propulsion of electromobiles. Noticeable amongst

these is the Joel, in which the armature constructed on the drum principle is arranged outside an eight-pole field, round which it revolves.

The modern electric motor is the most efficient machine in existence. Motors can be constructed which convert upwards of ninety per cent. of the electric energy supplied to them into mechanical energy. The efficiency declines as the size of the motor diminishes, but motors of an eighty per cent. efficiency are practicable for automobile purposes.

The electric motor is also exceedingly compact. As regards the amount of space it occupies, it compares favourably with any other form giving the same amount of power. As regards weight it is slightly heavier than the petrol motor.

Its leading feature, however, is its magnificent flexibility. It will start from a position of rest and run up gradually to the required speed without jolt or jar, and as varying speeds can be obtained by grouping parts in the motors and the batteries, no change-speed gears are required in an electric car, a single speed reducing transmission gear being all that is needed.

Above all, the electric motor is practically noiseless, and it emits neither visible vapour nor effluvium.

Assuming a vehicle with running gear complete and motors mounted and geared to the driving-wheels, the motors have to be fed with energy in order that the car may be propelled—that is to say, we must in addition to the motors have a source of electric current present. A car with body, running gear, and motors geared in position, is a potentiality only. It requires an electric current to vivify it and enable it to move.

Attempts have been made to propel electric vehicles with primary batteries. They have neither been successful technically nor commercially. At the present day the secondary battery or accumulator is the only adequate source of electric current for the propulsion of motor vehicles which is self-contained and trustworthy. It is just conceivable that a car might be propelled by the recently introduced Cupron battery, but the attempt could hardly have commercial success.

An accumulator may be looked upon as a reversible primary battery.

It has already been assumed that everybody is familiar with the common or horseshoe magnet. It will also be assumed that everybody is acquainted with the ordinary galvanic battery, but it may not be amiss to recapitulate its leading features.

If a plate of pure zinc and a plate of pure carbon be immersed in dilute sulphuric acid and connected outside the vessel in which they are placed by a metal wire, an electric current will flow along the wire from the point at which it is connected with the carbon to the point at which it touches the zinc. The current, however, will not flow for long. Soon after the wire connection between the two plates has been made, it will be observed that the surface of the carbon plate becomes covered with a layer of bubbles of gas, which increase in quantity till the whole plate is covered and the bubbles disengage and rise to the surface. The bubbles are hydrogen gas (due to the decomposition of the acidulated water by the zinc), and their formation on the carbon plate stops the further production of the electric current, and is known as polarisation. In the ordinary Bunsen battery, the carbon plate is set up inside a porous vessel containing nitric acid—a powerful oxidising material—the zinc remaining immersed in dilute sulphuric acid. The nitric acid oxidises or burns up the disengaged hydrogen, and by so doing produces additional electric energy; and therefore the voltage of a Bunsen cell is higher than that of a plain zinc carbon combination. If we could keep all the contents of the porous pot from escaping outside it, we could restore a Bunsen battery to its original condition by passing an electric current in the opposite way to that originally produced. This would reproduce the nitric acid which had reacted with the hydrogen and redeposit on the zinc plate the zinc that had been dissolved by the sulphuric acid, in the same way as a metallic deposit is produced by electroplating. In this manner the battery would be restored to its original condition. This cannot be done in practice because

the nitric acid escapes from the porous pot and attacks the zinc directly.

One element of a secondary battery, or accumulator, consists of a so-called positive plate and a so-called negative plate immersed in dilute sulphuric acid. The positive plate consists of a leaden framework or grid filled up with electrically produced peroxide of lead. The negative plate consists of a corresponding leaden framework filled up with porous or spongy lead, also produced electrically. The positive plate corresponds to the carbon plus the nitric acid, the negative plate corresponds to the zinc in the primary battery. When the positive plate is connected by a conductor—say through a motor to the negative plate—an electric current passes from the one to the other, and the battery discharges. Instead, however, of the negative plate dissolving as in the case of a primary battery, the spongy lead becomes converted into sulphate without dissolving. The hydrogen gas which would appear at the surface of the positive plate is oxidised by the lead peroxide and reduces it. The electric pressure registered by a voltmeter arranged in the external circuit and connected to the positive and negative plates is a little over two volts when the accumulator is freshly charged. When the accumulator has given a certain amount of current for a certain length of time, a large proportion of the spongy lead on the negative plate becomes covered with sulphate of lead, and a large proportion of the lead peroxide on the positive plate becomes reduced. The electric pressure which the cell furnishes becomes diminished, and the accumulator is said to be discharged. The accumulator should under no circumstances be discharged after a voltmeter connected from plate to plate shows that the voltage has sunk to 1.75 volt per cell.

When a primary battery is discharged it cannot be used again except by renewing the materials, but an accumulator when it is discharged, by having furnished current for a certain prolonged period, can be charged—that is to say, restored to its original condition—by forcing the current through it the wrong

way, that is in the opposite direction to that in which the current flows when the accumulator is being discharged. It is this feature of the accumulator which renders it a practical appliance. When it has given out an electric current for a certain time, it is merely necessary to connect it to the terminals of a suitable source of current at the required pressure to recharge it. It is generally advisable to charge an accumulator at about the same rate—that is to say, at about the same number of amperes—that it normally discharges at, but this is not absolutely essential, as the charging rate may exceed that very considerably, and with a good type of cell it is practically only limited by the heating produced. The pressure or voltage required to charge a battery is somewhat higher than that which it gives out, and is generally about 2·5 to 2·6 volts per cell.

There are two types of accumulator batteries, those in which both positive and negative plates are ‘pasted,’ and those in which the positive plates are originally composed entirely of metallic lead, cast so as to expose a large surface to the action of the dilute sulphuric acid, a coating of peroxide of lead being formed upon it by the action of the electric current. In both types at the present day the negative plate is ‘pasted.’ Electromobiles have also been built by the Electric Motive Power Co. and successfully propelled with Planté positives and negatives, in which zinc in a pure form is deposited on a special conducting support unacted upon by dilute sulphuric acid. This gives the advantages of the Planté; positive durability and great length of life without increased weight. Batteries of this type have been two years in constant use. In general it may be assumed, however, that the type of automobile battery chiefly employed has both negatives and positives formed by ‘pasting.’

The process of manufacture of an accumulator cell will be best comprehended by reference to a special example. Fig. 8 shows the type of plate employed in the construction of the batteries built by the Accumulator Industries, Ltd. for the vehicles of the British Electromobile Co., Ltd., of which the ‘Powerful’ is a good example.

The first step in the process of manufacture of the plate depicted in fig. 8 consists of mounting a sheet of thin pure lead, perforated in the manner shown, in a heated mould, in which a raised edge undercut at the sides is cast on to it, together with the lug or connecting piece projecting from the top of the plate. The grid thus constructed is smeared level with a paste mainly composed of ground litharge moistened with dilute sulphuric acid. The paste contains other things also. After smearing, the plate is dried in a warm room until the paste is thoroughly dry and hard, and the plate is then mounted with several others in a forming vessel of dilute sulphuric acid, in which it is connected to the negative pole of a battery of accumulators or a dynamo. The action of the current finally reduces the litharge to the condition of porous metallic lead, and the plate is then a negative, suitable for being assembled with other plates to form a battery cell. The positive consists of somewhat thicker plates, similarly formed as negatives in the manner described, and then connected to the positive of a forming battery or dynamo till all the porous lead is changed into lead peroxide, when the plate has become

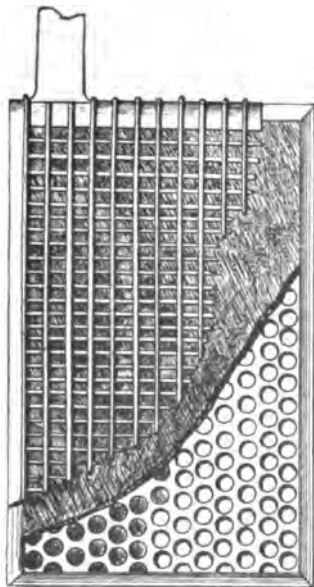


Fig. 8

a positive. Each of the plates, whether positive or negative, is covered over as shown in fig. 8 by a grille of ebonite, which assists in maintaining the actual material in position, and also serves to keep the plates apart. A number of positive

and negative plates, generally an even number of positives and an odd number of negatives, are assembled together in a cell as shown in fig. 9, additional vertical rods of ebonite being there shown in position to give wider separation

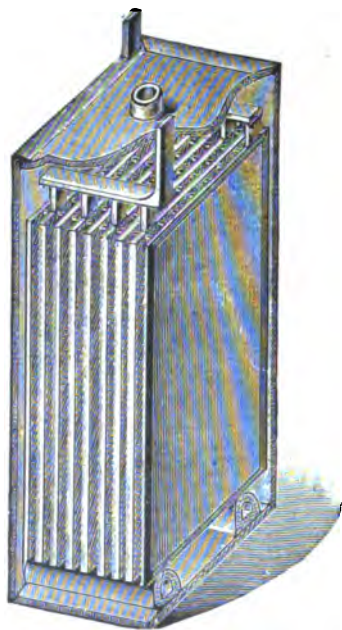


Fig. 9

between the plates. It will be observed that in fig. 9 the plates repose upon two longitudinal prominences at the bottom of the cell, which are technically known as bridges. These serve to keep the plates off the bottom of the vessel, so that if any of the material falls out between them, it shall not bridge across between the plates, causing a conducting connection to be formed, and the plates thereby discharged when not in use and injured. Each of the connecting lugs of each of the positive plates visible on the near top side of fig. 9 is autogenously soldered to a cross-connecting bar of lead, which is brought up vertically to form the positive terminal.

The negative plates are similarly connected to another cross bar, this being brought up through the cover on the far side and forming the negative terminal. The process of soldering is carried out either by a hydrogen flame or by an electric welder. When the formed plates are mounted in position as shown in fig. 9, the cover, provided with a central hole for pouring in the acid and allowing the escape of any gases generated when the cell is charged, is put on.

The containing vessel of automobile cells is almost in-

variably of ebonite, which has proved itself to be a light acid-resisting material, and the most suitable for the purpose. The general arrangement of the plates and cells is very similar in all automobile batteries. The plates themselves, however, differ in the shape and construction of the grid, which sometimes resembles an open network, as in the Rosenthal and Oppermann batteries, and also in the composition of the paste and the methods of formation adopted.

As it will be recollected that each such cell, as shown in fig. 9, gives only a voltage of approximately 2.0, and as it is found that, owing to various reasons, the most satisfactory design of motors for electromobile purposes involves their being supplied with current at between fifty and one hundred volts—preferably nearer one hundred volts than fifty—a number of accumulator cells have to be arranged in series—that is to say, the positive terminal of one connected to the negative terminal of the next—fifty cells thus connected giving approximately one hundred volts. Of course, according to the power of the motors they will take more or less current, which is measured, as already explained, in amperes, and the size of the cells supplied to a car is consequently so arranged that the normal rate of discharge of the battery—that is, the amount of current measured in amperes it can give without inconvenience to itself—shall be the same as the amount of amperes required by the motor or motors to develop their normal power.

It must be remembered that an accumulator or battery of accumulators can be so utilised that twice or three times the amount of current that it was designed to give may be taken out of it. This will not do much harm if it happens only rarely, and for short periods, but if it happens for long and often, it will shorten the accumulator's life. To get good results an accumulator should be treated with every possible care and consideration. An electric motor will also stand considerable overloading, but it is not so patient as the accumulator, for under most circumstances of at any rate prolonged overload, the motor will burn up before the

accumulator is seriously injured—of course assuming that the accumulator has been properly designed for the work that it has to do.

For use in a car, accumulators are usually—or at any rate preferably—mounted, about half a dozen together, in what are termed nesting-boxes—that is, wooden cases a little shallower than the cells themselves. Such a bunch of accumulators forms a unit which can be separately handled for removal or insertion in the vehicle. The connections between the cells composing it should be flexible and should be easily removable when required. Some constructors mount the whole of the cells in one nesting-box or tray, so that they can be inserted by mechanical means into a vehicle when charged, and instead of the vehicle being kept waiting for the process of charging, the discharged battery box can be withdrawn and a fresh one inserted.

Let us consider the running gear of a car such as is shown in fig. 12. The two motors are mounted on the rear axle and adapted to drive by means of spur gearing, consisting of a pinion and a rack both enclosed, each of the rear wheels of the vehicle independently. We will suppose that we have a battery of accumulators mounted on the framework above described, consisting, say, of forty cells, arranged in two groups of twenty cells each, one at the front part of the frame, and one at the rear. We have to consider the problem of connecting the batteries with the motors. This would be a simple business if the car were designed to run on the flat at an always uniform speed, and if the surface on which it would be its fate to run could always be satisfactory, such as an asphalted street, for example. It would then suffice to connect the two terminals of one of the batteries to the two brushes of one of the motors and the two terminals of the other battery to the two brushes of the other motor, by means of cables covered with insulating material, switches for making and interrupting the connection being arranged in between. Such a car, however, would only have one speed, and it would take an

enormous current at starting, which would be very liable to burn up the motors and injure the accumulators. In order to give different speeds and to enable the amount of current taken by the motors at starting to be reduced, arrangements must be made for connecting either the motors or the parts of the motors, or the two halves of the battery, or both in different groupings. It must be pointed out that more current can be put into an electric motor at starting than when running, owing to the fact that when running it produces a kind of back electric pressure.

If, then, we used on each of the motors at starting the full electric pressure our battery is capable of supplying, a great deal too much current would be forced through the motors and they would probably be burnt up. We may reduce the effective pressure applied to the motors by putting the two halves of the battery in parallel, when we should be working with a pressure of forty volts instead of eighty. We may also work further in the same direction by putting the motors in series, thereby doubling the effective resistance opposed to the current. To enable this to be done we want, however, to take several connections from the motors and several connections from the battery, and connect them by cables to a number of different points between which the required electrical connections can be established by means of an appliance termed a controller. This usually involves some such arrangement as is depicted in fig. 10, which shows the controller used in the Joel car. It consists of a non-conducting cylinder along which strips of metal are arranged, the cables uniting the different terminals of the battery and the motors being brought up to the flat springs which are shown pressing against the cylinder. Turning the cylinder round by means of the lever connected with it on the right produces electrical junction of such a kind as to group the motors and batteries in various ways according to the requirements for starting, for producing different speeds, forward and reversing in accordance with the principles above described.

A multiplicity of arrangements may be adopted and have been adopted in electric cars, involving corresponding differences of structure in the running gear and the controlling arrangements. To begin with, a car may have one motor, which may



Fig. 10

be arranged to drive the rear wheels by chains from the ends of the motor-shaft, the driving wheels in this case running on a fixed rear axle. Or the driving wheels may be mounted on a live rear axle, the motor driving on to the compensating gear, either by a chain, by spur gearing, or by means of worm gearing, which gives a nice silent drive, and is used in the Oppermann cars. In any case the use of a single motor involves, in addition to the motor, a differential gear. What is

to be avoided is a live rear axle with the motor so mounted that any large proportion of its weight comes on this live axle. This tends to cause distortion, with ultimate increased friction in the bearings and loss of efficiency. A very good system of mounting a single motor is illustrated by the recent De Dion vehicles, in which a single motor drives on to a separately supported compensating gear through an arbor-shaft, the compensating gear being connected to the driving wheels by jointed rods. This enables motor and compensating gear to be mounted on the upper side of the springs, both being thereby comparatively protected from vibration.

The advantages of a single motor are that it can be built with a somewhat higher efficiency than can be obtained with two separate motors, each of half the power. It is questionable whether there are any other advantages.

Cars employing two motors may have them mounted either to drive the front wheels, in which case the motors are necessarily mounted so as to turn with the wheels, or the motors may be mounted one to drive each of the rear wheels either by spur gearing (fig. 12) or by chains.

The Krieger cars are conspicuous examples of the former class, and are in fact the only electromobiles in this country in which this method of driving has been utilised. The disadvantages are that there is a tendency for the wheels to slip when the car is going uphill on greasy roads.

The latter class with two motors comprises an immense number of most conspicuous and successful vehicles, amongst which are those of the City and Suburban Electric Vehicle Co., Ltd. The advantages of two motors are numerous. In the first place, they practically ensure the car being supplied with sufficient motive power, as the limit in size of an efficient motor makes it practically certain that a car provided with two will be able to get along. In the second place, if anything happens to one of the motors at a distance from home, it is almost always possible at a sacrifice of speed to get home with one. Thirdly, a greater variety of speeds can be obtained; and

fourthly, no mechanical compensating gears are necessary, two series or separately excited motors acting as differentials to one another.

As regards the class of motor employed, the majority of electromobiles are propelled by series motors, a smaller number by compound motors, some very successfully by separately excited motors, and very few by shunt motors. The great majority of motors in actual use have four poles.

The principle of separate excitation has some advantages. It enables great *torque* or rotary pull to be obtained, without as much loss in the windings of the field magnets as is involved in the case of the series motor. In the separate excitation method of arranging, two or four cells are usually connected separately to the windings of the field magnets, the main battery supplying current to the armature. With the armatures in series an excellent differential gear is produced, while with the armatures in parallel, which only occurs at high speed, a steadying effect tending to keep the car straight results. This arrangement is employed in the cars of the Accumulator Industries, Ltd. The separately excited field motor, in addition to possessing, as already stated, certain of the advantages of the series motor, enables a very agreeable variation of speed to be obtained economically between the regular speeds by inserting resistance into the field magnet circuits. This acts like the accelerators on a petrol car.

According as one motor or two are employed, the groupings which the controller is arranged and designed to effect will of necessity vary also. Where a single motor is employed, unless it be compounded and used in some such way as in the Krieger system, differences of speed must be arranged for by grouping the battery cells in different arrangements. Thus a position of the controller will be arranged for which puts all the cells in series on to the motor. Running on the flat this will give the highest speed. The next lower speed will naturally be obtained by putting the cells in two bunches in parallel with one another; that is to say, the positive terminals

of each half battery will be connected together to one brush of the motor, and the negative terminals connected together to the other. This will provide half the pressure of the whole battery, and as the speed of the motor at the same load is dependent on the pressure at which the current is supplied to it, the car will travel more slowly. Lower speeds are produced by similar groupings giving lower pressure. Where two motors are employed a smaller number of groupings of the cells may be adopted, or double the number of speeds obtained with the same number of cell groupings, as with each cell grouping the motors may be arranged either in series or parallel with one another. In this case the maximum speed will of course be with the cells in series and the motors in parallel, the lowest speed with the motors in series and the cells grouped so as to give the lowest pressure. Generally one of the lower speeds - that is, with the cells arranged to give the lowest pressure - will be used for starting; as the motor, owing to its taking a large current before its speed increases, should not be supplied with current at a high pressure. As the batteries also, when arranged in parallel groups, are able to yield a heavier current, the arrangement is mutually satisfactory to both batteries and motors. For reversing, the controller is brought into such a position as to send the current the reverse way through the motor.

An electric car does not require change-speed gear because it contains practically a gear in itself. It accommodates itself to the load and does its best at any given load, or by varying the electric pressure it may be caused to increase or diminish its power within limits. Thus a series or separately excited motor can develop proportionately more torque in overcoming an increased load than it was developing before the load was enlarged. This effect may be increased by arranging the field magnets with a large amount of iron in their cores, and working under ordinary circumstances with a small magnetic density. On heavy loads, as when going uphill, the increased magnetic intensity produced by the increased current passing

through the windings of the field magnets increases the torque, and at the same time tends to check the actual speed of the motor, thereby giving what may be looked upon as an electric gearing effect.

Another point of interest is that a motor when being driven becomes a dynamo, and is capable of charging accumulators. Thus a suitable motor, when the car is running downhill, will give back current to the cells—will in fact ‘recuperate’ them. A good deal of misunderstanding has arisen in connection with this question of recuperation. It is

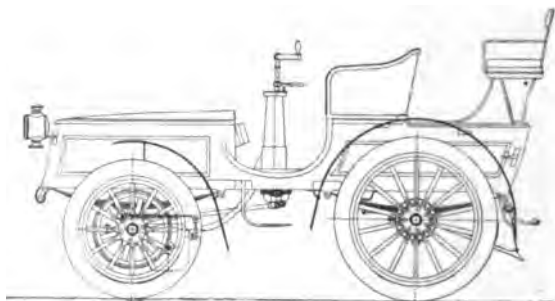


Fig. 11

not merely that some of the energy which would otherwise be lost in friction produced by putting on the brakes is, as it were, caught and put back into the cells, but that the conditions of running are more favourable to the battery, when occasional short charges are put into it in this way, than when it is subjected to continuous discharge. The car is also rendered more controllable. It is advisable for every electric car to be provided with a voltmeter and ammeter in view of the driver's seat, so that he may know the condition of his cells and the amount of current he is taking out of them.

Fig. 11 shows a side elevation of a typical modern electric car—the ‘Powerful’ of the British Electromobile Co., Ltd. This car made the record long distance run in this country

and an extended tour. It is of the Krieger type, and has a motor mounted on each of the front wheels, which they drive



Fig. 12

by spur gearing. It has two batteries of Leitner accumulators, one under the bonnet and one under the rear seat. The controller for arranging the connection between these latter and

the motors, and grouping the parts of the motors as required, surrounds the vertical steering pillar.

Fig. 12 shows the running gear of one of the City and Suburban Electric Carriage Company's electric vehicles. Two series motors mounted on the fixed rear axle drive by pinions on to gear rings secured to the spokes of the wheels. This company has adopted a system of trading by which for an annual payment of 186/ a purchaser of any vehicle can have it kept practically new for an indefinite period.

In accordance with the practice that has been observed in treating of other types of automobile vehicles, it is proposed to give a short description of the ills and misfortunes to which electromobiles are subject, together with some very cursory directions for detecting them and effecting their cure.

To begin with, however, it may be observed that an electromobile is much less liable to disarrangement of its functions than almost any other type of automobile. When the car is finished and provided with properly designed and geared electromotors, and furnished with an adequate battery and properly constructed controller and connections, it very rarely happens that anything gets out of order, and practically mishaps can only occur when a heavy electric vehicle is being forced up a steep hill either through heavy mud or at irrational speed. There is no doubt whatever that the trustworthiness of an electromobile is one of its most attractive characteristics, and that it comes nearer to being a 'fool proof' vehicle than any other type of automobile.

If anything goes wrong with an electromobile it is well-nigh bound to be something happening either to :

The electric motors

The battery

The controller, or

The connections.

Of course, in addition to these things, gears may get out of order, tyres may puncture or come off, axles may break ; but such misfortunes are common to all cars, and it is not proposed

to treat of them here. As regards the gearing breaking or stripping, that is comparatively inexcusable in an electromobile, as the kind of effort which an electric motor exercises is a steady and continuous one, and the gearing is subjected to none of the jerks and jars which occur when an explosion engine is the motive power, and when change-speed gear is varied by an inexperienced hand.

The motors may fail from various causes. The most common of these is burning up, due in general to forcing too much current through them either to get up a steep and muddy hill, or less generally in an attempt to run the vehicle up to or beyond the due limit of speed. When the motor proposes to burn up there is no doubt at all about the fact. It begins usually some minutes previously to diffuse an agreeable perfume, not very dissimilar to the smell of incense, the result of the vaporisation of the shellac which is used in the insulation of the windings. It is quite possible for a motor to diffuse this perfume without actually burning up, this merely being an evidence that the motor is getting extremely hot; but the wise man when he perceives it will usually, if possible, put his controller into position to give less current to his motors. Burning up may take place either in the field magnets or the armature, not very often in both at once. It nearly always means rewinding the part affected—an expensive performance. The burning up of an armature, however, is always much worse than the burning up of a field, as nearly everybody can wind a field, but an armature winder is a skilled mechanic, who commands high wages and often puts on airs. Sometimes, without actually burning up, the heating will cause failure of insulation between the windings of a motor, and then the motor, though continuing to run, will take considerably more current for the same power developed. It is better to rewind or get rid of a motor in this condition.

A motor may under circumstances refuse its work altogether, that is to say object to starting, though in a well-constructed car this is a very unusual occurrence. It may be due practically

to two causes: to the brushes not making contact on the commutator, which can easily be seen by pressing on the brushes with the hand, or to imperfect contact between some of the segments of the commutator and the windings, where they are soldered into it. The best way to ascertain whether this latter defect occurs is to get a dry cell and a galvanometer or voltmeter, and test the motor through from section to section of the commutator. If a point is found in which no current passes through the motor from a segment of the commutator, the conductor running to that segment ought to be properly sweated, i.e. soldered, in.

It is, perhaps, as well to explain the manner in which this kind of testing should be conducted, and the principle on which it is based; as a great number of possible faults in an electric vehicle may be detected by its means.

For an electric current to pass from the positive terminal of a battery or dry cell to the negative there must be a metallic or conducting circuit from one to the other. If the galvanometer or voltmeter be included in this circuit, then if the metallic connection be all right, on making contact to the dry cell or other battery used, the needle of the galvanometer will move. Thus, let a flexible wire be attached to one terminal of the cell, the other end of it being preferably soldered to a point mounted in a wooden handle, and let this point be pressed upon one section of the commutator. The other terminal of the cell should be connected to one terminal of the galvanometer, and the other terminal of the galvanometer to a similar metal point by a flexible wire to that first described, also preferably mounted in a handle. If this be then pressed upon the section of the commutator which should correspond with the first, then, if all be right, the current will pass from the positive of the cell through the coils of the motor, through the galvanometer, back to the negatives of the cell, and the galvanometer needle will move. This shows that there is metallic connection from one point to the other. If this connection be imperfect the needle will not move.

Failure occurring in the batteries is practically never a sudden affair. It generally makes itself apparent by gradual diminution of capacity—that is to say, the batteries refuse to give their proper amount of current for the required time, and this state of things gradually gets worse and worse. It is nearly always due to the batteries being forced to give more current for prolonged periods than they should, and generally results from the dropping out of paste from the positive plates, or to an interference with the continuity of the paste and the conductor. In badly mounted batteries—that is to say, those in which the plates are set up either without a bridge or without a sufficient bridge—failure may be due to short circuiting, owing to some of the active material falling out on to the bottom of the cell, and bridging the plates across. In general, however, the failure of a well-constructed battery, within the period for which it ought to run, is due to overwork.

It is well at intervals to employ a cell-testing voltmeter to test all the different cells, as it may sometimes happen that one or two cells get into bad condition. If their voltage is low towards the end of a run the main battery will be charging them round the wrong way, and they will in consequence be injured. If the same cells persistently show low voltage, they ought to be removed and examined. Hence easily detachable connections are advisable.

The injury nearly always occurs to the *positive plates*. Consequently a battery that has been maltreated may practically be rendered as good as new by renewing the positive plates. As the connections, battery boxes, and negative plates are not influenced, renewal of the positive plates can generally be effected at a reasonable price.

All battery connections should be seen to every day, and if any sign of oxide or verdigris appears should be promptly removed and cleaned. They should also be kept thoroughly tight. Perhaps the proprietor of an electric vehicle would do better, if he suspects his batteries of being in an unsatisfactory condition, to get them inspected by the builder of the cells, as

it requires some special experience to know whether a battery really requires renewal, whether the positive plates only should be renewed, or in fact how it should be treated.

Failure of connection between the controller, cylinder, and the contact springs may also give rise to stoppage. That is very easily tested by putting the controller in the position in which the car refuses to move, and testing the contact springs by pressing them against the cylinder. If the car then goes on they require tightening.

If the batteries and motors are all right in any particular position, and the car refuses to move even when the controller is tested in the above-described manner, there may be failure in the connections. Whether this is so or not can to a certain extent be judged by noticing whether the controller sparks when moved from one position to another. If it does so the current is passing and the connections are presumably all right ; otherwise the connections are probably faulty. They can be conveniently tested with a dry cell and galvanometer in the same way as the motor is described above as being examined. Heating at any point is usually the effect of a loose contact.

If the conducting cables are badly arranged, so as to rub on any metallic portion of the car, the insulation may be worn through and short circuiting ultimately result. It is therefore of the greatest importance to see that no such contact of the cables with any portion of the car ever occurs.

Similarly, accumulator connections should preferably only be made to the nesting-boxes and the connections with the cables made from contacts on these.

Electric vehicles can be charged in two ways, either by connecting the car directly to a suitable source of current, or by employing two or more batteries, one of which is always kept charged at the charging station, the arrangement being that when the battery on the car is run down it is taken out and a freshly charged battery inserted. This latter arrangement is usually only practised in stations or 'garages' where a number of cars are kept. Charging on the car is a much more

common proceeding. For this purpose the car should be provided with a plug and short length of cable, which should be carried with it. It is also advisable to have variable resistance. In charging the battery the cells are of course all arranged in series. Forty-four cells are often selected as the number employed, as such a battery can be conveniently charged at any ordinary direct current electric light station, which are usually designed to supply current at 110 volts or more. It is as well that every car should be provided with a switch which can be used for interrupting all connection between the cells and the motors of the vehicle while charging, as otherwise somebody moving the controller may cause the car to start off suddenly at full speed and take a header into a wall or a piece of moving machinery. A lock for the controller is nearly as good.

It must be borne in mind in charging a battery of accumulators that the voltage required is in excess of that which the cells give when discharging. Thus a forty-four cell battery will give about eighty-eight to ninety volts for car propulsion, but it will require something over one hundred volts to charge it. The variable resistance mentioned above should be inserted in the circuit so as to enable the amount of current charged into the cells to be controlled. When it is desired to economise the time occupied in charging, more current may be run in during the earlier stages, the amount being gradually diminished towards the end of the charge. The approach of the completion of the charge is marked by the 'gasing' of the cells—that is, the dilute acid fizzes more or less like soda water. The strength of the acid also increases as the cells are charged, and the increase may be used to show when charging is complete. A small glass vessel called a hydrometer, which can be inserted into the acid, and indicates its specific gravity, is used for this purpose.

Of course batteries can be charged from any electric lighting circuit that gives the necessary pressure or a higher one, as the forty-four-cell battery could be charged from a

two-hundred-volt circuit, but a great deal of resistance would have to be used in series with the battery, which consumes energy, and hence makes the process an expensive one. The cost would be very nearly double that of charging from a hundred-volt circuit.

In conclusion a few words may be devoted to the characteristic features, position and prospects, of the electric vehicle.



The Electric Car on which the Marquis de Chasseloup-Laubat, on March 4, 1899, covered a kilometre, from rest, in $48\frac{1}{2}$ seconds, and with flying start in $38\frac{1}{2}$ seconds

Since the first long-distance run to Brighton on a single charge was made by the Electrical Undertakings car, in June 1898, there is no doubt that the position of electromobilism in this country has steadily improved. The electric vehicle, however, does not enjoy anything like the same amount of popularity in this country, even at present, that it does in America and France. This was until recently no doubt partially due to the comparative dearth of charging stations. With the inauguration of a wise and sensible policy such as

that initiated by the City and Suburban Electric Carriage Co., Ltd., and referred to above, and with the increase in the number of charging stations, and their more general availability, the prospects of the electric vehicle are bound to improve.

With cars built as they now can be and are, to run a hundred miles on a single charge, the electromobilist can practically go



City and Suburban Co.'s Electric Brougham

anywhere. All he need do is to exercise a certain amount of foresight, and arrange that the end of his day's run lands him in the neighbourhood of a charging station.

The car has many very great advantages. As already pointed out it is comparatively 'fool-proof.' It is practically noiseless, or can be made so. It has great flexibility and changes from

one speed to another without jolt, jerk, or jar. The driver is not compelled to keep his eye on a water-gauge or the contents of a fuel tank, or to manipulate change-speed gears, sparking levers or the like. All he need trouble about is his steering gear and the position of his controller, with a very occasional glance at his voltmeter and ammeter. Above all the electro-mobile has no odour of its own, nor does it incur any danger of being run in by intelligent police constables for showing vapour and at the same time travelling above four miles an hour.

CHAPTER XIV

MOTOR CYCLES

BY THE EDITOR OF 'THE MOTOR-CAR JOURNAL'

To those who can realise, by actual possession, the pleasures of the motor-car, this chapter will be of little interest. But there are many aspiring motorists to whom the original cost of a car, or its maintenance when purchased, is a barrier to ownership. Hence the favour with which motor cycles are regarded, and the growing importance they are attaining in the automobile movement. The familiar forms are the tricycle, quadricycle, and the bicycle, the latter having rapidly come to the front, to the apparent supersession of the more cumbersome type of motor cycle. With regard to the permanent popularity of either form nothing need be said, individual preference being left to settle the question. But it may be pointed out that the bicycle is more conveniently adapted for storing where space is limited, and that it is to this kind of motor cycle that the attention of makers is being mostly directed at the present time.

There is no doubt that the motor cycle will prove an effective educational medium in connection with automobilism, for the intending motorist will be able to learn all about petrol engines at a much less cost than is demanded by the purchase of a motor-car. The experience thus gained will be extremely useful should the motor cyclist ultimately become the owner of a larger vehicle, while those who begin with motor cycles will probably enter the ranks of motor-car owners after they have realised the pleasures and delights of automobilism—

whether with the cheaper or the more expensive form. Thus the cycle will do much to popularise motoring.

For all practical purposes the motor cycle comes under the Light Locomotives Act of 1896 and the Local Government Board regulations by which its speed is restricted to twelve miles an hour. Restive horses and policemen must also be respected, and the motor cyclist must halt upon a signal from the driver of the former or the raising of the hand of the latter. Lights must be carried as on ordinary bicycles. In addition to observing these regulations, the owners of motor quadricycles, tricycles, or bicycles must take out licences—at the cost of 2*l.* 2*s.* in the case of the quadricycle, and of 1*s.* in that of the others. Efficient brakes must also be provided.

Apart from machines now regarded as curiosities, the motor tricycle of MM. de Dion and Bouton was the most successful form of vehicle introduced after the adaptation of the internal combustion engine to road locomotion. The first made had a small $\frac{3}{4}$ -horse-power motor fixed to the rear axle, the carburetter being placed behind the main down tube to the frame. The size of the motor was gradually increased, until we now find tricycles in ordinary use with air-cooled motors of $2\frac{3}{4}$ -horse-power capacity. Of a similar design was the Phœbus tricycle fitted with the Aster motor. It differed only in minor points from other machines, and in the use of copper radiating gills tightly fixed on the cylinder of the motor, the advantage of which (as Mr. Worby Beaumont remarks) is not very apparent. The Beeston tricycle was the first of the kind English-made throughout, but the Ariel motor tricycle was the first really successful English machine. It shows several variations in design from the original De Dion. Notably, the motor, instead of being placed to the rear of the back axle, is placed forward of it. A single case fills up the whole of the space in the main frame, and contains the battery, carburetter, and petrol tank. There are a few other motor tricycles, but their main features are on the lines of the above.

Passing to motor bicycles, they are of such recent develop

ment that they really have no history. Although Daimler designed a motor bicycle in 1885, it was not till five or six years ago that serious and sustained efforts were made to perfect the petrol motor bicycle. In this connection the Wulfmüller was a pioneer. It had a double-cylinder motor, driving the hind wheel, and was a cumbersome and unsuccessful machine. The Werner occupies a similar position among motor bicycles to the De Dion among motor tricycles. While gear driving has been universally adopted in the latter, most of the motor bicycles have been adapted for belt driving. One—that invented by Lieut.-Col. Holden—has dispensed with both, and has the novel feature of a four-cylindered engine, from which the motion is transmitted to cranks on the back wheel by means of connecting-rods. The Holden has another point of difference from the common practice in the fact that the cylinders of the engine are water-jacketed, while air-cooled motors are almost universally employed on motor bicycles.

The first point of interest in connection with motor bicycles is the position of the engine, and owing to the practice in the early Werner machines, where the motor was fixed above the front wheel, it was long thought that the weight of the engine should be placed as high upon the bicycle as possible. That location, it was claimed, was necessary to ensure the stability of the machine, and to minimise the danger of side-slip. Experience, however, has shown that this is not so essential, and there are now a score or more of motor bicycles only two of which have the engine above the wheels. In the latest type of Werner the engine is placed halfway between the two wheels in a vertical position, thus bringing the centre of gravity very low. A low-down position between the wheels is being generally adopted, as tending to reduce the vibration and lessen the liability to side-slip.

The subject of side-slip is one of the greatest interest to all motor cyclists, and the position of the motor has been variously located, with a view of minimising its occurrence. It is generally acknowledged that motor bicycles are more prone to

dangerous side-slips than are ordinary leg-propelled cycles. On a slippery road with the ordinary bicycle there is only the rider and the bicycle in question, but in the case of the motor bicycle the engine makes its presence felt, lessening that instantaneous and automatic control so essential for safety. The Minerva engine has been adopted on many bicycles. It is now of $1\frac{1}{2}$ h.-p.; the carburetter is a simple form of the surface type, and the petrol consumption stated to be about one pint for twelve to fourteen miles on level roads. The engine can also be lubricated without dismounting. In the Minerva motor bicycle the engine is fixed below the bottom tube of the frame slightly forward of the bottom bracket. The Excelsior was one of the first British motor bicycles in which the Minerva engine and system was adopted. Indeed, the extensive employment of the Minerva motor is one of the most astonishing features of the present development in motor bicycles. It is noteworthy, however, that several leading makers, while using the Minerva, have introduced in connection with it a number of special features which considerably facilitate the handling of the machine.

In the Quadrant motor cycle matters are simplified by one lever being made to control the switch, open and close the exhaust-valve, regulate the gas-supply, and vary the sparking. This reduction of the number of levers is undoubtedly a step in the right direction. The gas can be supplied in varying quantities, as usual, and is regulated by the lever from the lowest to the fullest supply before the advance of the sparking begins. Then when a greater speed is sought, it is obtained by the advance of the sparking, according to the pace desired, or in other words, the explosions are more rapid, the quantity of gas used being, of course, the full charge. In the ordinary arrangement it is possible to vary the supply of gas allowed to pass to the explosion chamber with the sparking lever at any point. Whether the restrictions imposed in this direction by the Quadrant device will prove to be a drawback has yet to be tested.

In the Phoenix motor bicycle, the Minerva engine is adopted with two or three ingenious additions. The switch is controlled from the handle-bar, the electrical contact being arranged near the engine. The switch lever is so arranged that when further moved the exhaust-valve is lifted. In the same bicycle, the space between the down diagonal and the rear wheel is used for a specially shaped tank for petrol, giving a total available supply sufficient for a run of 200 miles. The Enfield has its motor highly placed in front of the head of the frame and driving the rear wheel, the only combination of this position with rear driving that has been introduced. The Mitchell and the Thomas motor bicycles (which are of American design) have the motor above the bottom tube but close to the head. The Brown machine, which is of English design and construction, follows somewhat the practice of the last two named, but the motor is fixed lower down on the bottom tube. In the Shaw motor bicycle the motor is attached vertically in the rear frame, driving the rear wheel either by belt or chain as desired.

Power transmission, a subject already incidentally mentioned, is an important point with regard to motor bicycles.

Belt-driving was originally the only medium considered, as it overcomes much of the vibration, although the tendency to slip is an obvious disadvantage. The V section belt was selected for the early types, but in the Minerva motor bicycle a twisted belt is used, the slack in which can be taken up by increasing the twists. Even with this, however, there are disadvantages, and when riding in wet weather on sandy roads we have known it to grind the groove of the pulley-wheel, slipping of the belt naturally resulting. Although powdered resin may be a temporary cure for this, the best way is to untwist the belt and twist it in the reverse direction. In the new Werner flat belts with flat pulleys are used, and in the United States an endless raw-hide rope is adopted in some machines.

An innovation is made in the Singer motor bicycle in locating the whole of the mechanism in the driving wheel.

The engine is placed vertically, and the Simms-Bosch magneto ignition is adopted. A modified surface type of carburetter is employed, and one small lever suffices to effect the whole of the control. In the Derby machine, a chain from the engine propels a friction roller bearing on the tyre, which is thus driven by frictional contact. It is claimed by the advocates of this system that no extra wear on the tyre results. Latterly, chains or cog-wheels have been experimented with, but machines with this kind of driving cannot as yet be said to have been thoroughly tested, and it remains to be seen whether chain or gear driving will obviate the drawbacks to the belt without introducing disadvantages of their own. Chains are employed in the Humber motor bicycle, a friction disc faced with leather being introduced to slip slightly when undue pressure falls on the chain. In this case the motor is an essential part of the frame, and forms the bottom tube.

No final judgment can be given on this question of transmission, for like everything else about motor bicycles, the whole subject is in a state of transition. But the difficulty is especially great when we find experts divided. There are two gentlemen of the name of Craig who have each devoted much attention to this subject. Mr. A. Craig of Putney tells us that he considers 'that in spite of slipping and breaking, belt transmission is the best. It is simplest and cheapest, and under good conditions an almost ideal drive.' He prefers a flat belt, of at least one inch width, and a jockey pulley on ball bearings. The jockey pulley is always abused because its purpose is misunderstood. It is not meant to jam the belt up tight, but to make it hug as much as possible of the circumference of the driving pulley. Twisted leather belts are in his opinion a nuisance. On the other hand, Mr. A. Craig of Coventry says, 'It has been a matter of surprise that the belt should have survived so long as a means of transmission in motor bicycles. Probably, the belt drive will eventually lose favour except for low-powered machines, and some form of chain or gear drive take its place.'

Sir Róger de Coverley would probably have called this a case of 'much to be said on both sides,' and suggested that experience should determine the result.

Future developments in connection with motor bicycles will no doubt be concerned with spring frames and two-speed gears. Already some interesting work in these directions has been done, and in the latest types of Excelsior motor a spring head is employed which greatly reduces the vibration transmitted to the handle-bars. One drawback to the use of the motor bicycle in hilly districts is that the motor only gives out its full power when running at the normal speed. When going uphill the speed of the motor naturally slackens, and consequently the engine does not give off its standard capacity. To overcome this difficulty inventors are studying the matter from two different points of view. Some are in favour of the use of motors of higher capacity than those now in general use, while others are experimenting with two-speed gears, arguing that it is better to have a small engine kept steadily running, and so developing its full power notwithstanding the gradient, the low gear being used for hill climbing. The Chapelle, which is constructed on these lines, has already proved its capacity in several French races, and the Phoenix motor bicycle has just been introduced with a two-speed gear as a leading feature. Motor cycling, although hitherto enjoyed only by the male sex, is likely to prove attractive to ladies in the future, and already machines have been specially introduced for their benefit. The motor is placed below the bottom tube, and ample protection is afforded in the way of dress-guards, &c.

The novice need have no fear of his motor bicycle. It is not a haphazard aggregation of bits of metal, and although there are bicycle motors composed of more than 140 separate pieces, they present no unfathomable mystery. But the mechanism requires understanding, and we advise the intending motor cyclist carefully to study the chapters on Petrol Engines, Ignition, &c., in this book. A clear understanding of these

will conduce to the pleasure of early experiences, which otherwise may be more varied than delightful. Even then he will have much to learn before he can qualify for a police certificate as to his ability to attain a speed above the legal limit. Diplomas for obstruction can be more easily obtained in public thoroughfares, hence the advisability of early runs being taken in secluded districts.

Before setting out, the cycle should be carefully examined and the engine tried. It is necessary, too, to be assured that the tool-bag contains the requisite equipment of tools and spare parts. We can remember on one occasion a friend of ours had glanced over the mechanism of his cycle, and had made sure that everything was satisfactory. Removing the interrupter he retired to clean his hands after the operation. Returning to his bicycle, he exerted himself on the pedals, but no explosion occurred. Dismounting he again overhauled the machine, spent ten minutes or so in investigation, and was ultimately warned by a constable for creating an obstruction in the roadway. He tried everything except, let us hope, profanity, and was preparing to seek friendly aid, when, casually putting his hand in his pocket, he discovered the interrupter plug, and his troubles were quickly over. Many of the so-called failures of motor cycles are due to equally trivial causes.

There is nothing consistent about our English climate—except its variability; and the motor cycle must rise superior to changeable climatic conditions. During cold weather those riders whose machines are fitted with surface carburetters have often been troubled with regard to the 'mixture,' and even in the summer-time, when riding over very bumpy roads, the petrol in the carburetter will be thrown about, giving off more vapour than is required, and affecting the running of the motor. The only way to overcome this difficulty is by continually controlling the air inlet. A number of riders of the 1901 Werner got over the difficulty in winter by warming the carburetter by means of a branch from the exhaust-box, a flexible tube being used. It is not, however, an easy matter on this machine, the motor being on the head stem of the bicycle, and moving

independently of the carburetter. Another plan is to procure some boiling water, and after soaking rags in it to wrap them round the carburetter till the petrol is warm enough to vaporise sufficiently. In many of the new designs of bicycles, however, spray-type automatic carburetters are being fitted. No doubt these have certain advantages over the surface type, but with their use the necessity of seeing that no dirt or foreign matter gets into the petrol tank becomes an urgent question. They should be placed as near as possible to a source of heat to prevent them from becoming frozen in cold weather.

In the majority of motor cycles electrical ignition of the jump spark type is adopted, although in a few cases the magneto arrangement is being employed. The escape of the electric current or the premature running down of the battery is one frequent cause of trouble where dry batteries or accumulators are used. It may result from loose electrical connections, bad contacts, and short circuits. If two of the terminals of the wires get connected with a film of moisture, a short circuit is the inevitable outcome: hence extreme care should be taken when riding for a considerable time in the rain. The rider should frequently test the accumulator with a voltmeter to see that the necessary charge is there, or if a dry battery is used, test the amperemeter, and he should always carry a spare battery. Then he should see that all contacts and connections are firmly made, and that every wire connection is covered and properly insulated. There may be trouble through the platinum points of the contact-breaker getting worn down or dirty with oil, or the platinum, on what is known as the 'trembler' (whether it trembles or not is a debatable point), becomes loose and causes jumpy progression of the machine. The remedies are obvious: clean the contact points or replace with a new 'trembler.' If the cautions here given are observed there should be freedom from electrical troubles between the battery and the sparking plug.

Sparking plugs are often a source of worry, but a friend has travelled 11,000 miles and only required three plugs. Apart

from an absolute fracture of the porcelain, the main cause of stoppage is owing to the plug inside the cylinder becoming fouled with carbon through an imperfect mixture being used. Often too much lubricating oil is inserted in the crank-case. This then gets over the top of the piston and is burnt up when an explosion takes place, leaving a heavy deposit of soot. When this occurs the plug should be removed and the points cleaned.

In long runs, when the motor becomes heated, the inlet valve-stem may stick on its seat through oil or the bye-products of the explosion getting on to the stems. A little petrol squirted by an ordinary bicycle oil-can on to the stem will generally overcome the difficulty. Another plan is to take out the inlet-valve and wash the stem with the finest black-lead and petrol. On evaporation the stem will be left well coated with black-lead, which is a very good lubricant where there is great heat.

In order that the motor should work well it is necessary to have good compression. In the four-cycle engine the charge is compressed every second stroke of the piston towards the head of the cylinder. To obtain good compression, which is the forcing of the mixture into a smaller area, there must be no leaks, and the cylinder, piston, and valves must be perfectly tight. Otherwise, when the mixture is reduced in volume it will leak out and there will be poor compression, with the result that the motor will not give anything like its proper power, the force of the explosion being greatly reduced. Such working, too, is not economical. It is necessary, therefore, to see that there are absolutely no leaks, and the points where leaking can occur are as follows:—(1) the inlet-valve; (2) at the sparking plug; (3) around the piston-rings; (4) at the exhaust-valve; (5) at the point between the explosion chamber and the cylinder-top, where the cylinder-head is fitted on to the cylinder. Every little leak, no matter how small, means a loss of power. The valves should be examined first, viz. the inlet and the exhaust. They should be packed with suitable washers, and it should be seen that they set firmly on their

seats. If there is any wearing of the metal the valves should be ground until the surfaces are perfectly smooth, so that an absolutely tight joint is made on the seating. Sometimes the ignition plug is not properly screwed up, and this should be looked to; there should also be proper packing between the plug and the cylinder at the junction. One of the most important places to look for leaks is at the piston-rings. These are set in grooves on the side of the piston, and make it fit tightly in the cylinder. On account of the excessively high temperature inside the cylinder, which dries up the lubrication, the rings may not run well, and will allow power to be lost, particularly if the engine has been out of use for a time. A little paraffin dropped into the cylinder through the compression tap will ensure free and proper operation of the piston-rings. The petrol motor is a very economical producer of power, unless something like a leak or bad ignition is taking place, and while really simpler than a steam engine, it seems more difficult of comprehension to the budding motorist.

The owner of a motor cycle who expects to use it constantly without previous experience, and not run up against various sources of stoppage and breakage, will find himself mistaken. A frequent experience is to run the whole gamut of troubles, and thus by actual knowledge having learned to fix all the various parts, the operator is qualified to take care of his machine. These troubles occur for three principal reasons. First, the ordinary individual who buys a motor cycle will not make a careful study of the manner in which the machine is built and how it works, but prefers to tackle it on the 'hit and miss' plan and learn by hard knocks and experience. Second, carelessness and the disinclination many persons have to take proper care of a piece of machinery. A motor cycle, however, cannot be expected to run properly unless it receives regular attention. Third, from accidents pure and simple. As already explained, a great deal of trouble might be avoided if riders would only take the pains to understand the principle of the machine before attempting long journeys.

CHAPTER XV

MOTOR-DRIVING

BY S. F. EDGE AND CHARLES JARROTT

THE motor-car, when in the hands of a careful and experienced driver, is admittedly the safest form of vehicle on the road, the chief reason for this being the rapidity with which it can be stopped, even when travelling at high speeds, and also the ease with which under the same conditions it can be diverted from its course into the direction desired by the driver. These two points are known to nearly every well-informed person, and the knowledge really constitutes a danger to the unaccustomed controller of a car, as road conditions may entirely upset all the previous experience of the novice, and the apparently great simplicity of control inspiring confidence at much too early a stage of his novitiate, he may become a most dangerous user of the road, although driving the simplest form, or rather the most controllable form, of road vehicle.

Every action of starting, stopping, changing, and diverting should be absolutely automatic, and until this has become so slow speeds only should be attempted. A man may be perfectly able to perform all the special driving functions when not flurried, and when his attention is not disturbed by exciting events, but he may become hopelessly involved at the very moment when the greatest skill and judgment are required from him—for instance, when in an emergency the pedal brake ought to be applied, instead of pressing down this brake, which would at once stop the vehicle, he may hurriedly press down the accelerator pedal, which has the effect of increasing the

speed, and thus, possibly, an accident of a most serious nature results.

Again, nothing but practical experience will teach a novice the correct speed to drive round a given curve, for the conditions of the road alone may cause a speed perfectly safe on a dry day to be absolutely dangerous on a wet day ; probably one quarter the speed possible on a dry day would be too fast and dangerous when the road is wet.

Greasy roads are the greatest danger of all to the novice, and yet when the driver has acquired enough skill to gauge the correct speed to drive over them, and keeps himself within the limit of that speed, there is little or no fear of mishap. Here, again, however, even an experienced driver is sometimes inclined to run the risk of driving the car at a greater speed than the road-surface warrants ; and consequently if brakes have to be applied suddenly, and the car pulled up in a short space, there is a possibility of a bad side-slip. The great point on greasy roads is to drive cautiously.

It is an exceedingly awkward and dangerous occurrence when a car runs backwards down a hill, through, perhaps, a chain breaking, or the driver missing the gear in changing speed. This may possibly happen before the novice has ever thought of learning to drive backwards, and the lesson under this nerve-shattering circumstance probably results in his having a big repair bill to face, to say nothing of doctors' bills.

Perhaps in endeavouring to initiate the beginner into the art and apparent mystery of controlling and driving a motor-car, it would be as well to start from the beginning. We will assume that the car has arrived home and everything is ready to set off for the first drive. Although we wish to give all possible hints in this direction, it is well to remember that the greatest safeguard, when you take your first lesson, is to have on the car with you a really good driver so that he may be ready to act if a combination of circumstances should require a rapidity of decision and action that cannot have been acquired by the novice.

Assuming that the vehicle is in perfect condition for use and the engine has been set going, the first thing to do is to examine the ways and means of starting the carriage either forward or backward, to ascertain how to stop it when desired, and steer it from side to side or round a corner, or to avoid an obstacle. We will suppose that the vehicle is of the Panhard type, with wheel steering and single lever at the right-hand side, giving the speeds forward and reverse. On taking a position in the driver's seat with one foot on each side of the steering column, each foot lightly resting on the two driving pedals, it will be found that the left pedal when pressed down disconnects the engine from the driving mechanism, whilst the right one also does this, but at the same time applies a powerful brake to arrest the motion of the vehicle.

Slightly to the right of the right-hand pedal will be found a smaller pedal set somewhat higher than the other two. This is called the 'accelerator pedal,' and its function is to hold out the governor of the engine and cause it to run at a greatly increased velocity, and so force the vehicle to exceed its regulated speeds. The use and misuse of this valuable adjunct to the motor-car engine will be dealt with later.

The change-speed lever is on the right hand, and by its side is another notched lever which applies a band brake to each of the rear-wheel hubs; also when applied it disconnects the engine from the driving mechanism, so that when one wishes to stop, this brake lever first disconnects the engine and then retards the momentum of the car, thus performing the same function as the two pedals operated by the feet and referred to above. With these general points carefully noted, a start may be made, and we will imagine that the car has been standing as it should be when the engine is running, i.e. with the speed lever in the neutral notch and the side brakes on, and thus, of course, the engine disconnected from the gear.

First Speed.—First place the left foot on the left pedal, press this down as far as it will go and hold it there. Then take off the side-brake lever, move the speed lever forward one

notch—that is, to the first or low speed—and slowly lift the left foot until you feel the engine beginning to move the car. Immediately it does this, if only for a yard or two, press the left pedal down again, so as to get thoroughly accustomed to the feeling of the car moving forward with its own power and yet stopping immediately the pedal for disconnecting the power is pressed down.

When once confidence is acquired, and the novice feels that the car is quite under his control, longer distances, say fifty feet at a time, may be attempted ; but as it will be obvious that in this distance some momentum will have been attained, and that even though the left pedal is pressed down the carriage still rolls on, opportunity has now come for making use of the right pedal. This being pressed down gradually by the right foot, at the same time still keeping the left pedal down, applies the band brake and so stops the car.

Second Speed.—Having now thoroughly mastered starting and stopping on the low speed, a change may be made into the second speed. To accomplish this, first get the vehicle running as fast as possible on the first speed, then press down the left pedal quickly, push the speed lever firmly into the second forward notch, and lift up the left pedal gently as when starting. You are now on the second speed, which you will no doubt observe is considerably faster than the lower speed, and the novice should familiarise himself with this in the same way as on the first speed, i.e. letting the car run short distances and thus becoming accustomed to the speed. Keep on the low and second speeds until you feel thoroughly at home and confident that the car will do that which you mechanically direct it to do. Remember that with a motor-car the driver controls the vehicle, and in this it differs from a horse-drawn vehicle, in which the driver is often at the mercy of the animal, to be pulled here, backed there, or upset altogether should this chance to please the noble quadruped.

Third Speed.—The third speed may now be used, and you obtain this under exactly the same circumstances and in

exactly the same way as set out in the explanation of changing from the first to the second speed. It will be well if some long runs be taken at this stage, no speed higher than the third being attempted. When this stage is reached, it will be found very much better to take four or five drives of ten miles each, with half an hour or an hour's stoppage between, rather than one continuous drive of forty or fifty miles. Much more rapid progress will be made in this way, and the mental and physical strain is then not noticed, whereas if one long ride is attempted straight off, the novice, when he gets down from the car, will feel uncomfortably tired and exhausted. The next day, if possible, more driving should be undertaken, but this time on the second speed, first directing the steering with one hand and then with the other, so that perfect control can be exercised with either hand, the hand that is more or less at liberty being engaged in taking articles out of the pocket, &c., adjusting the lubricators, pumping oil into the cylinders, and other small details of this sort, which at times it is expedient to do when actually on a journey. One can never feel at all secure until either hand will do all that is necessary with regard to steering. When one is thoroughly familiar with steering with one hand on the second speed, then higher speed can be attempted.

How to Change Speed properly.—In changing speeds there are various things to be avoided, and the learner will very quickly realise that it is most difficult, if not well nigh impossible, to change speed without withdrawing the clutch; which operation is performed by pressing down the left pedal. In any case if he does succeed in the attempt, it will be at the expense of a great deal of noise and damage to the teeth of the gear-wheels. Under all circumstances the teeth are made to engage with one movement, and if at the beginning it is found that when attempting to change speed a grinding noise is heard, it is best to stop the car completely and not persevere, but change the speed quietly with the car standing stationary. When this has been done, and it is brought absolutely home to the learner that the speed can be changed, then he must revert

to the lower speed and begin all over again, until he can change each speed easily and quietly while the car is running ; it is only a question of practice. The clutch-pedal must be pressed down firmly and decisively without haste or any violent force.

There is another important factor in regard to changing speeds which must be considered, and that is, to change speed at the proper time in relation to the speed at which the car itself is travelling. The usual mistakes on the part of the novice in changing speed are :—

1. To change to a higher speed too soon.
2. After withdrawing the clutch, not changing speed soon enough, thus allowing the carriage to run too slowly to enable him to change on to a higher speed.
3. Often in ascending hills he does not change to the next lower speed quickly enough. It is always well to remember that in going uphill the engine is best when kept at its maximum rate of speed ; if it drops below this, change to a lower gear at once. This is especially important if you are driving a powerful car, as the strain thrown on the clutch when driving on too high a gear will not improve that very important item of the car's anatomy.

A very good formula to follow in regard to changing speeds is to continue on the speed on which you are running until the engine cuts out or shows signs of extra vibration or noise, which will at once indicate to you that it is running faster than it ought, and that it is desirable to change on to the next speed. This will ensure there being a good run on the car, and that the next higher speed will take up the run and increase the pace.

In changing to a lower speed, it is always well to change in good time directly the car exhibits the slightest sign of flagging on the speed it is then running on, as one must remember that immediately the clutch is withdrawn on an upgrade the car starts slowing, and if one does not change quickly, it will not pull even on the next lower speed. The result of this will be that, instead of changing back to one speed,

the driver will have to change down two speeds to keep the car running properly. It is therefore highly necessary, before trying long drives in a hilly country, that this point should be thoroughly mastered. The same remarks apply in ordinary driving. It is always well to keep within the power of the engine, and after having stopped or slowed down it is advisable to change back to a lower speed so as to ensure the engine plenty of power to start the car again.

Accelerator.—It would perhaps be as well here to explain the use of the third pedal referred to before as the 'accelerator pedal.' While not essential to the proper running of the car, it can be made of considerable use in driving.

The type of motor carriage we have described is fitted with an engine which governs out at approximately 750 to 800 revolutions a minute. If, however, the governor is held up—and this is what the accelerator pedal accomplishes—of course the engine speed is considerably increased and the speed of the car is increased accordingly; but though the accelerator pedal is beneficial in the hands of a careful and considerate driver, it can be abused to the damage of the engine and gear in the hands of a rough or careless driver.

To race the engine on any and every conceivable occasion is obviously improper; but it will be found that to accelerate a little when wishing to change (but before doing so), especially when going uphill, will assist very materially in accomplishing the change of speed successfully.

Overrunning the Engine.—We will suppose that you are running down a steep hill with the speed lever set in the third speed—with the left pedal down and the motor consequently disconnected—and this third speed gives, say, a rate of twenty miles an hour. The car, however, from its own momentum and the force of gravity, may be running at twenty-five miles an hour, and to let the clutch in then throws a very unfair strain on the engine. It must be remembered that the engine has to drive the car and not the car the engine, which if caused to rotate at a much greater speed than that for which it was

constructed may result in a serious breakage. Therefore do not let the clutch in until the speed of the car is sufficiently reduced to give the engine some work to do when the pedal is lifted up.

Starting for a Drive.—There are many points which require to be thought over when starting for a drive, so as to make sure that everything is in order and that the necessary spare parts are carried. Although it seems a formidable list, it is curious how very quickly one gets used to running mentally over all these items, and after a time never forgetting anything.

The main points to be thought of are to make certain that the tanks are full of petrol. A good way of dealing with this matter is to fill up with petrol whenever there is a suitable opportunity, as this ensures the car always being ready to travel its maximum distance without any special preparation. It is then necessary to see that the water tanks are full, that your working and spare accumulators are fully charged, that all the lubricators and grease cups are absolutely full, and that some spare lubricating oil is carried. Also a number of spare parts should be taken, such as spare exhaust-valve and spring, spare inlet-valve complete, three spare sparking plugs, spare inner tubes and repair outfit. Besides these,

A large screw wrench.

Small pocket wrench.

Long screwdriver.

Small screwdriver.

Pair of cutting pliers.

Pair of gas pliers.

Two files, medium size.

Coil of copper and steel wire.

Oil-can with long nozzle.

Small cold chisel.

Supposing all then is ready, the next thing to do is to start the engine, and the points to be gone through are as follows :—

1. Turn on petrol.
2. Switch on ignition.

3. See that the lever to the commutator is retarded as far as possible. (This is done to make certain that no back-fire will occur.)

4. Turn on lubricator.

5. Start engine.

Before Starting the Engine.—One of the most important things to do before attempting to start the engine is to see that the speed lever is in the out-of-gear notch. The importance of this cannot be emphasised too much. We have seen a number of accidents of a more or less serious nature result from the neglect of this precaution. We remember particularly on one occasion a friend started up a car with the speed lever in the forward notch but with the side brakes on, thus holding out the cone. The vibration of the engine shook the brake lever out of its notch, it jumped the cone, and off jumped the car. As this took place on the edge of a very high cliff within a few yards from the brink, observers went through the agonising experience of seeing a trusty little car and an agitated driver struggling for supremacy—the one to plunge over the edge into space and the other to prevent this catastrophe. Luckily the fly-wheel of the engine struck on a mound and stopped the car with the two front wheels over the edge of the cliff. Make it therefore a golden rule: never leave your car, whether the engine is running or not, without first putting the speed lever in the out-of-gear position and also putting the side brakes on.

It sometimes happens that, although all the operations set out above have been performed, the engine does not respond to the turning of the handle. Under these circumstances, it is well just to jump the float needle up and down once or twice, to make certain that a little petrol has gone into the carburetter. It may seem rather unnecessary to have to recapitulate all these minor points, but it has often occurred that even experienced drivers have tried for quite a long time to start their car without the electric current being turned on, and in some cases have started their car, and driven a few yards, when

the engine has unaccountably stopped, and after some searching they have found that the petrol was not turned on.

The troubles in regard to the starting, &c. of the engine are dealt with in the chapter on the Petrol Motor.

Lubrication.—Although perhaps this subject is hardly one which should be dealt with in this chapter, it is of such great importance to ensure the successful running of the car that it cannot be dwelt upon too much. Lubrication above all things spells life to the motor-car, and the lack of it must result sooner or later in disaster. Therefore see before starting for a drive that all the bearings of the car are properly lubricated, and also be sure during the drive that the lubricator to the engine is working satisfactorily.

After having been for a drive or having the engine running, the next thing to do is to go through another set of regular functions which should always take place before putting the car away. Turn off electric current, or if lamp ignition, blow out lamps, and after a few minutes turn off petrol to the lamps; turn off main petrol to carburetter, turn off lubricators, and then have the engine turned smartly by hand and a little paraffin pumped into the cylinders from the pump provided for this purpose. This is to ensure that the piston rings shall not become gummy or sticky, and it is a great point in assisting the engine to start easily next time.

Driving Backwards.—After having conquered all the initial difficulties in regard to steering, changing speed, application of brakes, &c., it would be well for the novice to start learning to steer and drive the car with the speed lever in the reverse.

There are comparatively few men who can drive backwards safely and well, but the importance of being able to do this must be very apparent. When driving in traffic it is a very common thing for the vehicle in front to back, and in this event it must be the work of a moment to slip the speed lever into the reverse notch and run back out of danger. To turn in a narrow road where the reverse is required also calls for some knowledge of handling the car when running backwards,

and in the event of the car running backwards when ascending a steep hill the vital importance of being able to steer it safely is obvious. Skill in this direction has great advantages. We recall an instance of an automobilist who, having had the misfortune to break the forward bevel driving wheel on his car, slipped in the reverse and drove into London—some twenty miles—steering the car backwards. He complained, however, of having a stiff neck for some days afterwards.

The novice should practise on some quiet wide country road until he attains sufficient proficiency to drive the car backwards at the rate of at least eight or nine miles an hour.

Test your Brakes.—Every wise chauffeur takes the precaution of testing his brakes immediately he starts driving. During a stop something may happen to the brakes so as to make them quite ineffective, or a portion of the brake mechanism may have broken. The driver who perhaps before luncheon has ascertained that his brakes are acting perfectly, after luncheon may start off in the same supposition, and perhaps not discover his error until, relying on his pedal brake to stop him in traffic, he finds that it has no effect, with the result that he probably goes through the back of a brougham.

The Sprag.—This is an adjunct fitted to most cars. In the early stages of driving, it is as well always to leave this down when ascending steep hills, so that in the event of the novice missing his change of speed, or if through any other cause the car tried to run backwards, it would be arrested in its early movement and damage obviated.

It should be borne in mind, however, that the sprag should be dropped before the car actually starts to run backwards; otherwise the momentum on the car may induce it to jump the sprag to the danger of the passengers and the great annoyance of the chauffeur, who finds that before being able to proceed he will have either to detach the sprag or cut it away. We remember seeing the owner of a large motor carriage in this predicament. After taking the precaution of having a solid sprag fitted, he spent some hours beneath his



HOW TO TAKE A CORNER

car in an endeavour to cut through a solid inch and a half of iron with a very blunt hack saw.

Immediately the necessity for the use of the sprag has disappeared, it is as well to pull it up at once by the cord.

Going round Corners.—Always keep to your right side, remembering that in all probability you will find some other vehicle coming towards you from the opposite direction. It will generally be found that as the road slopes towards the gutter, the outside wheels of the carriage will be higher than the inside. This not only helps one round the curve, but at the same time lessens the risk of upsetting if the speed was higher than should have been attempted for such a curve. The novice in hugging the corner would only be following the exact practice of the railway companies in banking the outside rail up higher than the inside on rounding curves, but must keep a good look-out ahead, and in the event of not being able to see round the curve should not drive at a greater speed than that at which the car can be pulled up immediately, should occasion require it.

Descending Steep Hills.—When travelling down steep hills it is very easy to be deceived, as the nature of the district may make the gradients look very much less than they really are. A very striking example of this occurred in the Thousand Miles Trial of the Automobile Club, when the Hon. C. S. Rolls, in driving from the 'Cat and Fiddle,' was evidently so deceived by both the gradient and the corner that he actually threw his mechanic off the car, owing to the vehicle travelling at much higher rate than was allowed for, and the gradient -keeping the car running at a great speed right up to the corner. The present writer himself, who was just behind Mr. Rolls at the moment, to a certain extent met with the same difficulty. It is always desirable, even when great experience is reached, to travel with the utmost caution under strange surroundings and to keep the car well in hand.

Using the Brakes.—A very good rule to follow is that under ordinary circumstances the brakes should not be used with

such violence as to cause the wheels to skid, or to occasion a jar to those driving in the carriage. If this is carefully observed the vehicle will last much longer.

We are aware that it is the habit of some drivers to do what is known as 'drive on their brakes'—that is to say, rush up to an obstacle at full speed and then rely upon their brakes to prevent them from dashing into it. However brilliant it may appear to the uninitiated, the practice cannot be too strongly condemned; for not only does an exhibition of this sort try the nerves of the passengers on the car—however seasoned they may be—but it also produces a bad impression on the public, who, not appreciating the control the driver has over his vehicle, marvels at his apparently narrow escape. This sort of thing comes under the heading of inconsiderate driving, and is not only unnecessary but at the same time bad form. The danger of the practice is also very great. It will be remembered that a very serious accident occurred some time ago on a hill near Harrow through this very cause. The unfortunate driver, who was killed, was one who was well known to rely on his brakes to an extraordinary extent, driving full speed up to his stopping point and then applying the brakes with very full force and stopping in the shortest possible space of time. In the early days of the sport this was thought by some to be a sign of good and skilful driving, but experience has taught us that the best driver is the careful driver who takes no unnecessary risks.

The sudden application of the brakes and the consequent locking of the wheels is to be commended from a pneumatic tyre manufacturer's point of view, but from no other.

Dangers of the Road.—Some of the greatest dangers to be met with on the road arise from other people, not because they are there, but because of their indecision; and in the forefront must be put people alighting from tramcars, or children holding on to the backs of carts and trams. They suddenly hear the motor approaching, and although their safest plan is to remain where they are, they make wild dives in any and every

direction, with the result that, unless one has the car completely under control and ready to stop at a moment's notice, a bad accident may happen. It is a good rule when meeting with undecided wayfarers to make up one's mind the way one wants to go and continue in that direction; at the same time keep your brakes well in hand, so that if necessary you can pull up dead and avoid striking them.

Lady cyclists are or used to be a great danger, for when a motor was heard approaching them from behind, they usually fell off their bicycles, apparently in terror; but this distressing spectacle is now comparatively seldom seen.

A swerving horse which swings round at the last moment is another danger to be guarded against, and on approaching any horse it is always well to assume—as is too often the case—that it is not under the control of the person driving it; either he is intent on looking at the motor, or very likely he cannot drive. It is advisable to slow down to the pace at which the car can be pulled up immediately a horse shows signs of wanting to monopolise the whole of the road. This danger is very much increased if the horse is attached to a cart with a long piece of timber projecting at the back, as a very small movement of the animal may completely block the road. One or two very bad accidents have occurred thus.

In driving at high speeds avoid trying to look behind. A Belgian nobleman was lately killed owing to taking a glance behind him when driving a racing car. He apparently deflected his steering wheel a little, with the consequence that before he turned his head again the car had dashed into the bank by the roadside. The barbaric system of carrying small water drains in shallow trenches (known in France as *caniveaux*) across the surface of the road has been the cause of many accidents. They may be found in many French villages and on some English roads. They are difficult to detect, but a good driver should always have an eye for the road and be prepared to slow down to a walking speed in passing over these trenches. The same remarks apply to badly made level crossings of railways.

Some of these are disgracefully constructed. That at Colnbrook, on the Bath road, is an example of how they should be designed: that at Mortlake station of how they should not. Where the road crosses small streams the bridge is sometimes made in the shape of a sudden hump (the French call them donkeys' backs) instead of a gradual and nicely curved ascent and descent. These must not be attempted at high speeds. To drive fast over a trench, a bad railway crossing, or a bad hump, may result in broken springs, bent axles, and strained frames. The novice should bear in mind that cars are not designed for steeplechasing, and a broken horn of the front springs leads to the displacement of the steering gear, and possibly a sudden swoop across the road, into a wall, a ditch or—Eternity.

Side-slip.—We now come to another danger or difficulty, and that is side-slip—the bugbear of the expert as well as of the novice. Under certain conditions all roads in towns become exceedingly greasy and slippery to a rubber tyre, so much so that if the brakes are applied the carriage, instead of stopping, merely travels on with the wheels locked, and on greasy asphalté will go almost as far in this fashion as with the wheels revolving. Drivers are, however, never likely to meet with accidents from side-slip if they will only drive cautiously. In town, if one keeps in the ordinary line of traffic, and proceeds at the same pace as the other vehicles, the result should be perfect safety, for one can always stop as quickly as the ordinary 'bus in London, even under the worst conditions. There is simply no royal road to get over this difficulty except driving cautiously, and driving at such a speed that it is only necessary to apply the brake in a very gentle form. If one drives at greater speed than this, accidents are bound to happen, and no one but the driver is to blame.

In regard to the different types of greasy roads, asphalté is probably the worst, though greasy wood, and chalk or oolite road, are almost as bad. Perhaps the chalk road is the most dangerous, as one comes upon it out in the country when pos-



A SIDESLIP

sibly travelling at a high rate of speed. Greasy tram lines are also exceedingly bad, but as the car should be travelling slowly when these are encountered, accidents ought not to happen if proper care be used.

In passing over tram-lines they should be taken at a good angle, for if the crossing be cut too fine the wheels may drop into the lines and a slip result. Greasy macadam is bad if high speeds are attempted, but up to ten or twelve miles an hour there is seldom any difficulty in 'negotiating' it. Ice is the worst of all, but this condition occurs very seldom, and of course no attempt should be made to travel at any great speed over it. An account, however, of a drive under these circumstances is given by Mr. Mayhew in a recent issue of the Automobile Club's 'Notes and Notices,' and being of interest it is quoted :—

Mr. Mark Mayhew met with some exciting experiences on December 28th, when driving his twenty horse-power Panhard. After descending Aston Hill, and when within five miles of Oxford, he struck a strip of road which was solid ice, but which, owing to the thaw that had started, was running with water. He says—

Awful side-slip, hit side of road left, right, left, after which went straight again. One mile from Witney he noticed a sharp descent with a similarly treacherous surface. He had not time to pull up the car, so put the brakes on at the top of the hill, which stopped the driving wheels dead, while the car calmly glissaded to the bottom. When he got to the bottom he put in the clutch on the second speed, and essayed to run up the other side, but as soon as the momentum had fallen, the driving wheels began to slip, then the first speed was dropped in, but the car eventually stopped with the wheels revolving on the ice. Then, with the power still on, it slowly slid to the bottom of the valley backward. However, by getting some strips of sacking which he tied round the tyres, the summit was gained. It is suggested that the partial deflation of the back tyres might have helped Mr. Mayhew. Of course, the conditions were so exceptional that no provision is usually made for them. If they were common, it would certainly be necessary to have a sand box ; in fact, an adaptation of the railway steam sand blast, but worked from the exhaust, would be necessary !

When driving on greasy roads it is always well to keep as far away as possible from any vehicle in front, whether it be a motor-car, a horse-drawn vehicle, or a cycle, as this allows plenty of time to pull up slowly and gradually.

In regard to the various accidents which may happen to the car itself through outside causes, one thing to be remembered is that the fly-wheel or front axle of the car is probably not more than seven or eight inches above the ground ; therefore if very rutty roads are being used, it is well to direct the wheels out of the cart ruts and keep one rut in the centre of the vehicle. It is also well to keep a good look-out when entering park gates or stable yards where high centre stones are often placed, for if anything is struck by the fly-wheel it is almost certain to break or bend the crank-shaft of the engine, and a costly repair is necessitated.

A Punctured Tyre.—There is another little difficulty in regard to steering, and that is if a front-wheel tyre bursts or punctures, that side of the car is immediately somewhat lower, and owing to the tyre being flat, it exerts a severe retarding tendency to that side of the vehicle, with the result that if the right-hand tyre punctures, it tries hard to run to the right. This must be resisted and the car kept firmly on its course, the brakes being applied gently but firmly, and the car pulled up as quickly as possible without a sudden jerk. To give one some idea in an exaggerated form of the power exerted by a deflated tyre we will give a personal experience. When travelling on a big racing carriage over seventy miles per hour, the front tyre was cut by a broken piece of bottle, and in a second the tyre burst. The whole tyre and tube were torn off the wheel by the centrifugal force exercised and the car was running on the iron rim. In holding the steering straight against this tremendous pull, the steering-wheel steel shaft was twisted a quarter of a turn. Of course, if the car had been allowed to deflect for one moment from a straight line at this speed, a most frightful accident would have followed.

Night-driving.—When driving at night one should never travel at a speed greater than that which affords time to pull up after seeing any object clearly by the light of your lamps. Of course if two acetylene lamps are used one can travel up to twenty-five miles an hour in perfect safety, the road being sufficiently illuminated to give plenty of time to stop; but if ordinary oil or candle lamps are used, eight or ten miles is the limit of safety. In very foggy weather it is best to turn one lamp sideways so as to indicate the side of the road. The off-side lamp pointing forward should be covered with a handkerchief, to diffuse the light and cause less refraction from the fog in front.

One of the most difficult things to see on the road at night are sheep, as they make little noise when going along slowly, and seem to blend with the colour of the path. The writer remembers some years ago running into a flock of sheep from this cause when travelling late at night on a carriage having only candle lamps. The consequent smash and the amount of attendant repair bill are still engraven on his mind.

It must also be remembered that many people walking, seeing the lights of the car, assume that you see them as well as they see you. Again, it is almost impossible to believe, until one has had actual experience, how invisible some large objects are which may be on the road in front of you at night, and which it is impossible to see until one is within a few yards of them. In summer, probably owing to the roads being usually white, the light from one's lamp is much more effective than in winter. A very dark night is actually better for driving than a moonlight night with the moon partly obscured by clouds.

In conclusion, it is well to remember that under all circumstances a fixed habit of careful driving should be practised. Reckless driving has no utility, and must result in a serious accident sooner or later. The difference in the time taken by a careful driver and by a reckless driver in a day's journey is infinitesimal. To obtain this small gain, however, the reckless driver has probably incurred a tremendous number of risks all

totally unnecessary, and caused considerable annoyance to everyone else on the road.

Probably the chief offenders in this respect are the paid *mécaniciens* or drivers for companies or private owners. Having no responsibility, no care, no consequences to face—beyond the possible loss of the weekly wage—infinite damage can be done by a man of this type dashing through villages and crowded thoroughfares. Therefore impress the fact on your mechanic that your car is to be driven as considerately when you are off as when you are on it, and if your instructions are not carried out, cure the complaint by dismissing the man.

Grievances in regard to the speed of motor-cars would have had no ground if every driver took upon himself the obligation of gentlemanly conduct on the road, acknowledging that the highway is public and that a large number of other persons have equal rights to its use. Therefore slacken your speed in any and every place where you think that some other user of the highway may be inconvenienced by your passage.

CHAPTER XVI

THE CHARMS OF DRIVING IN MOTORS

BY THE RT. HON. SIR FRANCIS JEUNE, K.C.B.

THIS is an old country, and one of our most valuable pieces of inheritance is the ancient asset of good roads penetrating every corner of the island. New countries may have fine railways, but though, and perhaps because, they have fine railways they have not, and never will have, roads equal to ours. And it is not only an ancient, it is also a well-preserved asset. It is the duty of any one who uses the roads of Great Britain for motor-cars to express his gratitude perhaps to the ancient Romans, certainly to the old turnpike trustees and to their modern successors the county councils, and I say this the more emphatically in the hope of encouraging the county councils to persevere in their good work. These roads are the sphere of the motor-car, and my belief is that, could we consult our friends the horses, there would be whatever in the case of horses corresponds to a plebiscite in favour of utilising it to the fullest extent.

Many persons did, and, I am afraid, some persons do still, accuse us of a love of too rapid progression. I feel inclined myself to plead guilty to the limited extent of acknowledging that there is a glorious exhilaration in the mere motion of a motor-car, strong, unwearying, unresting, with no drawback of regret for strain of exertion on man or beast. The mere sense of motion is a delightful thing ; the gallop of a horse over elastic turf, the rush of a bicycle down-hill with a suspicion of favouring wind, the rhythmical swing of an eight-oar, the tramping progress of a four-in-hand, the striding swoop on skates

across the frozen fens—all these are things of which the reminiscence and the echo come back to us with the dash and pulsations of the motor-car. Even Dr. Johnson thought that nothing was so delightful as the rapid motion of the post-chaise. I should like to have given the sage a lift in a motor-car, and gained for the world the testimony to a sensation of delight by a philosopher theretofore undreamt of in his philosophy.

And in this pleasure of motion we are; if not independent of the weather, at least almost independent of seasons. The hotter the sun the more agreeable the fanning of the air through which we pass, and the cold of winter, guarded against in proper fashion, carries with it its own exhilaration. To my mind the greatest pleasures and the greatest advantages derivable from the motor-car are the power of traversing large areas of the beautiful country in which it is our happiness to live. The use of motors in town is increasing and, doubtless, will greatly increase. It is no small advantage to be able to go from place to place with no thought of tiring horses and no fear of cold through waiting. But even to those living in towns, the country contributes most to the pleasure of possessing a motor. At one of the dinners of the Automobile Club, when it was suggested that motors had a future in bringing agricultural produce to the large towns, the audience agreed with the observation that, if it was desirable that the motor should bring cabbages to the workman, it was still more desirable for the motor to take the workman to the cabbages. For myself, after a long day in Court, I often feel that I am a workman who wants to be taken to the cabbages. I remember hearing it said that, in his last illness, Lord Beaconsfield derived great pleasure and benefit from driving in the lanes of the north of London, amid surroundings of the rural character of which, so near London, he had hitherto little idea. Where are those lanes now after an interval of only twenty years? The ring of suburban habitations grows constantly deeper and denser, and it is, I think, an invaluable

function of the motor-car that for many years to come it can, even in an idle hour or two, carry us from the heart of the metropolis into the woods and fields of genuine country. It is a case of civilisation providing an antidote for its own poison, and I for one am glad to be able to enjoy both the poison and the remedy.

The country is, however, and I think it always will be, the best sphere of the motor. I am afraid I cannot help recurring to my personal experience, but judging from that, a motor justifies its existence best from the great, the never-ending, the ever-changing delight of travelling through many miles of country surroundings.

To many of us come all the pleasures and excitement of exploration. I am sure most persons know of a corner of their counties, previously as inaccessible as the North Pole, which can now be visited with no fear of a chill welcome at the end, and with the prospect of the consumption of something better than the train oil of the Esquimaux *gourmet*. If we live near a range of hills there is the perpetual curiosity as to what is to be seen on the other side. I believe that the Duke of Wellington used to say that the best general was the man who knew what was on the other side of a hill. We are all of us in that sense qualifying to be generals now, with the difference that the knowledge we gain is that of friends and not of enemies. Even if the country through which we pass is familiar, there is not only the pleasure of seeing it under the different aspects of weather and season, but there is the interest of observing the behaviour of our faithful car, as it traverses distances and mounts hills, of the difficulties of which we are often possibly only too well cognisant. And there are not many districts, I should suppose, which have not at least one hill to excite the aspiration of unsatisfied ambition.

But we clip the wings of the possibilities of motors if we limit them to travels of which a home is the immediate centre. The trials organised by the Automobile Club point to the practicability of journeys for which our country is so admirably adapted.

The motor-car may become a land yacht with more variety of scenery than its marine prototype, and an absence of the frequently disconcerting motion peculiar to the sea. I do not at all depreciate the pleasure of travelling over a beautiful country in a railway. No one who has looked down from the Brenner Pass into Italy, no one who has climbed up the spiral line to Andermatt, or who has speeded over the sunny plains of France or even the expanses of Russia, at least in the luxury Russian railway-carriages afford, will doubt that railways can give an adequate experience of scenery of a grand and far-reaching character. But what do they know of England who only England know from the window of a railway-carriage?—the great plain or valley, even with its sunlit varieties of grass and corn and wood, contributes only a small part of the beauty which England has to show, but which she declines to disclose to the railway-traveller.

The voyager by road thinks less of a great expanse of scenery, bounded though it may be by the long waving line of mysterious hills, than he does of the thousand sights of beauty and interest under his eyes. A railway has no foreground, unless telegraph posts on an embankment half-clothed, and not at all ashamed, can be said to constitute such a feature. To a road and the traveller on it the foreground is everything. The hedges, the trees dappling the road with shade and sunshine, the cottages, the village greens and ponds, the village itself through which we pass with a fleeting interest in its life, the glimpses down side lanes into their infinite suggestions of light and colour—these are sights repeated in the endless variety of nature and rural life, and of which the changeful pleasure is unending. I am not sure whether the motor-car is as popular in the rural districts as it is, or at least I believe was, in France, but I fancy that to-day, if we choose, we shall not find our neighbour anything but cordial. We revive in these later days very much of the spirit of the old coaches, and we may perhaps revive something of the interest in them of the country inns and the people of the country. Speaking again

for myself, I have never found the country people anything but kindly and interested, and indeed quite ready to enjoy the new experience. I remember once somewhere in Somersetshire a herd of most leisurely beasts slowly preceding us on their way to market, entirely declining to make room for us to pass, as is their fashion, and followed by their herdsman. Gradually the procession assumed the form of the beasts travelling at a somewhat, though not much, accelerated speed, the car close behind and the herdsman panting in the rear, till with a complete appreciation of the situation, he hurried up to say, 'Seems to me, measter, if you be going to drive them beasts all the way to market you had better take me up.' The market fortunately was not far distant, but I think the herdsman would not have objected to a similar ride as each market day came round.

The old people seem to manifest more curiosity than the young. The school children, it is true, usually line the road and utter shouts of which I have never been able to discern the significance, or seek the delight, to me, I confess, wholly unintelligible, of throwing their caps under the advancing car. But when a car stops old people invariably surround it with criticism and inquiry. The witticism, 'Seems to me, measter, your horse can't get on without drinking any more than ourn,' never fails, and many an old lady gladly accepts the experience of a ride to the end of her village and back again. I wish I could add that horses in the country manifested more indifference than their owners. But I am afraid it is just the old agricultural horse, who looks wise enough to know better, that exhibits an unexpected excitement, unless indeed he is standing unlooked after by his master, in which case his indifference to the passing car is usually beyond all praise.

We have in the motor-car of the good type to-day a new and growing source of health, of pleasure and advantage, and we, who have been the first to avail ourselves of it, may without undue exaltation congratulate ourselves on our wisdom and those who follow us on our example.

CHAPTER XVII

ROADS

BY J. ST. LOE STRACHEY

THE RETURN TO THE ROAD¹

I

DURING the past five years the world has been brought face to face with the fact that carriages can be built which will travel along the roads with safety and comfort, carrying comparatively heavy loads, at a rate of speed which, if it does not rival that of an express train, is sufficient to make the way without rails quite capable of giving us all we want in the matter of fast short-distance transport. This fact makes it certain that the road is once more destined to play a great part in our national life. Already men of all kinds are beginning to talk about the roads, to ask as to the state of the roads, and to inquire into such questions as gradients, surface, width, straightness. When ordinary men travelled by the railway only and merely used a little section of road, hardly more than five or six miles long, to get to the nearest station, the road played a very small part in their lives. Now that travelling along fifty, or even a hundred miles of road is becoming common, and that the return to the road is almost accomplished, the old interest in the highway is, as I have said, reviving, and men are once again beginning to see the importance of the road.

¹ In this chapter I have resumed portions of articles dealing with our roads written by me in *The Spectator*.



PAST AND PRESENT

II

Of course the road never really lost its national importance. It was only that the quickness of railway travelling and the slowness of horse-transport made the road suffer a temporary eclipse—though while it lasted of a very complete kind. The old lawyers declared that title deeds were ‘the nerves and sinews of the land.’ In a very much more striking and real way the roads are ‘the nerves and sinews of the land.’ It is they that bind village to village, and town to town, and thread the centres of population as beads are threaded on a string. A moment’s reflection will show the vast importance of the part that has been, and must always be, played by roads in our national life. Though the country is covered by a network of railways, we do not, unless we are station-masters, live on the railways. The road is, as it were, the first wife of the nation, and though some sixty years ago the husband took a new wife home, he never discarded the first, and she has in reality always remained nearest to him, and has always held his home. Nothing can take that away from her. We live on the roads, and they are part and parcel of our daily lives. We look down the road for the home-comer, or the new-comer. Our gates open on the road. The road is always with us. The motor-car and the bicycle have restored to us a full remembrance of the fact. While railway travelling was so immeasurably quicker and easier than road travelling, we were forced to give up the pleasure our fathers had taken in the road, for mankind in general cannot or will not lose time. Now, however, the road has been revived. To go back to the marital and polygamous metaphor, just employed, the motor-car has given the road a crown of price that has once again made her find favour in the eyes of her lord and master. The second wife has come to look old-fashioned and dull, and the first wife, never really rejected, renews her claims. No one can deny that from the point of view of beauty this

return to the road is a gain. We only know England when we know her roads. The English roads are like wood-fringed rivers that run twisting and turning through our villages and towns. No one can travel down fifty miles of an English road without coming upon a hundred beautiful and unexpected things, and seeing those things in the best possible way and as they ought to be seen. When we see scenery from the railways, or, at any rate, the near-at-hand scenery, we are, as it were, looking at the brocade of the landscape on the wrong side. We see the pattern awry and upside down. We cut across the roads, not wind down them. We see the old church or the old manor-house not in a picture composed by centuries of usage and of kindly human courtesies. Things as seen from the railway are for the most part set on wrong, face the wrong way, and as it were 'grate on the sensitive ear with a slightly mercantile accent.' The coalshed or the chimney of the heating apparatus is turned towards us in the train, and not the best line of gables or the old lych gate.

III

Perhaps it will be said that all these prophecies as to a return to the road are of very doubtful value, that the motor-car can never really beat the railway, and that as soon as the present fad has passed away, the railway will return to its old ascendancy. I do not agree. The autocars will not, of course, rival or destroy the railways. The present railways will always continue to do the heavy and long-distance traffic of the country, while fast mono-rail electric railways will carry the express passenger traffic. Rather the motor-car will feed and immensely increase the demand for express trains and long-distance journeys. The motor-car will not so much injure the railway as call a new kind of traveller into existence. Cross-journey traffic with its many changes, suburban traffic and short-distance traffic may suffer, but it will be amply compensated for by a great increase in the demand for long-

distance tickets. The fact that will assert itself directly we have a proper supply of easy, quick, and comfortable motor-cars available, is the fact just named—i.e. *that we live on roads and do not live on railways*. The circumstance that a motor-car can stop at the garden gate if we live by a highway, or drive up the carriage-drive and draw up level with the porch if we live within lodge-gates, and take a man direct to the door of his office, or of his friend, or wherever he wants to go to, is bound to make the motor-car beat the train for all short-distance work. Let us take a concrete example. A British householder living in the middle of Kent—say thirty miles from the coast—is going to take his family to the seaside for the usual three weeks. At present the procedure is as follows : When the boxes are corded and the children and nurses ‘collected,’ they are packed into carriages or an omnibus and taken to the local station on a branch line. There the party and its impedimenta are put into the railway for twenty minutes or so—i.e. till they reach the main-line station. Here the babies and the bicycles are taken out, and after a wait of perhaps half an hour are repacked into the main-line train which carries the party to Bathington West. Here there is another breaking of bulk and temper, and the family is got into cabs and omnibuses and driven to the hotel or lodgings. To accomplish this journey there have been no less than three gettings in and out. If, however, it were possible for the householder to engage a light motor-car for himself and his wife and eldest daughter, a motor-brake for the children and servants, and a light steam-van for the luggage, bicycles, buckets and spades, and perambulators, which would load up, not against time, but quietly at the front and back doors, and unload at the hotel or lodgings, what a vast deal of fuss and worry would be saved ! Even if the journey, conducted at twelve miles an hour, took two hours and a half, it would hardly be so long as the time required for (1) driving two miles to the local station, say twenty minutes ; (2) getting tickets and arranging luggage, &c., fifteen minutes ; (3) going in local train to Buffing Junction, say twenty

minutes ; (4) waiting at Buffing Junction to catch express, thirty-five minutes ; (5) going from Buffing Junction to Bathington in express, thirty-five minutes ; (6) getting out luggage, &c., at Bathington, twenty minutes ; (7) losing time owing to late trains—say, twenty minutes in all. That is two hours and forty-five minutes—and who can say that I have exaggerated the delays and friction incident to an ordinary sea-side journey ?

IV

But if, as I firmly believe, the roads are going to come back to their old importance, certain facts will at once become apparent. Directly we use the roads for personal and rapid transport mankind in general will begin to find out what the bicyclists found out long ago—namely, that our roads are very ill-fitted for the purposes for which they are designed. To begin with, they are usually too narrow. Next, they are rough in surface, and on the hills very badly ‘graded.’ Lastly, in certain cases, although this would not often be necessary, a mile or two might be saved by a short cut. I do not propose, of course, that all these improvements should be made at once—and most assuredly all the improvements must be made with a due preservation of the beauty and charm of our country roads and the districts they traverse—but, no doubt, as soon as the importance of the roads, so long overshadowed by the railways, revives there will be a great and pressing cry for highway improvements. It must not be supposed that in urging the improvement of the roads I am thinking merely of the convenience of the drivers of motor-cars. I believe that the improvement of the roads and their restoration and revival would be of the greatest possible national benefit. We all deplore, and rightly deplore, the decay of the village, but nothing would so quickly and soundly help the village as the resurrection of the road. If the men of the villages within the ten-mile radius of London could jump into a motor omnibus or brake and be carried to London for a penny, as they could be, we

should have greatly helped to solve the housing problem. The simplicity of arrangement by which a man in the village could enter the omnibus at his own door and be carried straight to his work would greatly facilitate living in the country and working in town. But if this is to happen, as happen it ought, we shall at once have to deal with the disagreeable fact that London and most of our great towns are exceedingly difficult to approach by road. Almost all the high roads out of London run through a narrow neck, which is perpetually being blocked by traffic. A good example is Hammersmith Broadway. The Hounslow Road on the west and the great Hammersmith Road to the east sides of this Broadway are large and in every way adequate roads, but their size is rendered useless by the narrow half-mile of the much misnamed Broadway. This is not a solitary instance. In a word, if the roads are really to become great arteries of traffic under a system of automobile transport the authorities will have most seriously to consider the approaches to London. London, we hold, ought to be entered by at least eight great roads of uniform breadth, and the narrow necks like Hammersmith Broadway should be entirely abolished. It would be a very costly improvement, but it would be worth accomplishing.

V

It is easy to make out (1) that our roads are going to be vastly more used in the future than in the past, (2) that they have been neglected and cannot carry the increased traffic without great and unnecessary inconvenience being caused to the public, (3) that we ought to improve them. The difficult thing in a complicated political and social community like ours is to suggest how the roads are to be reformed. On the whole I incline to the belief that the plan proposed by the Roads Improvement Association (45 Parliament Street, S.W.) will prove the most practical.

Unfortunately, space does not permit me to state their

proposals, but I strongly advise all those interested in the subject to send for the documents issued by the Association and study them in detail. They involve radical changes, but are by no means unpractical, and I believe would go far to solve the problem.

But excellent as these proposals are they will of course be of no avail unless public opinion is awakened on the subject. That it will be awakened I cannot doubt, when motor-cars become cheaper, when the prejudice against them has died out completely, and when men find, as they soon will, that it is more economical to keep a motor-car, not only than a carriage and pair, but than a horse and trap.

VI

I have already mentioned how an improvement in the roads and the use of self-propelled carriages and carts will have a centrifugal effect on our great cities, and act as a very important factor in putting a stop to the increase in that urban congestion which has marked the last few years. This will of course be a great national benefit, but the dispersal of the town population will be by no means the only gain. Better roads and cheap and fast traction along them should help, and I believe will help, in the creation of a large number of small proprietors and small tenants—a change which all rural reformers desire. The small farmer, whether owner or occupier, will find it easier to get a living if and when the roads are good and easy of use. Competent observers of French life declare that the splendidly made and well-kept roads of France have greatly helped to keep the French peasant on the soil. For example, the Commercial Agent of the United States at St. Etienne, reporting in 1891 to his Government, wrote as follows :—

The road system of France has been of far greater value to the country as a means of raising the value of lands and of putting the small peasant proprietors in easy communication with their markets



IN DAYS OF YORE

than have the railways. It is the opinion of well-informed Frenchmen who have made a practical study of economic problems, that the superb roads of France have been one of the most steady and potent contributions to the material development of the marvellous financial elasticity of the country. The far-reaching and splendidly maintained road system has distinctly favoured the success of the small landed proprietors, and in their prosperity, and the ensuing distribution of wealth, lies the key to the secret of the wonderful financial vitality and solid prosperity of the French nation.

I believe this to be no exaggeration. The peasant's difficulty is always in finding ready cash to use in getting his goods to market. But if the roads are really good and do not wear horse and cart unduly, it is wonderful how cheaply a peasant with even the poorest of horses and the shakiest of carts can get his goods to market. If on the other hand the roads are stony and heavy and the gradients difficult, the man who cannot afford to keep good horses and carts and renew them often, is quickly beaten out of the market. Good roads give a very large amount of that fair field and no favour which we all desire for the small agriculturist.

VII

There is one more practical point to which I very strongly desire to draw attention. A great many eager eyes are at the present moment being cast upon the roads by the promoters of electric tramways, light railways and so forth. The keen-sighted business men who conduct these enterprises have already realised what the public has not, that all the world and his wife live on the road, and that the roads are indeed, as I have said, the nerves and sinews of the land. Very naturally then, they are striving to obtain the right to lay their lines along the roads, and so obtain the great profits that arise from place to place traffic. Now I entirely admit that, *prima facie*, there is no objection to these plans. They are, indeed, I believe, in themselves useful, and, carried out under proper conditions, there is no reason why they should not

confer great public benefits while paying good dividends to their shareholders. But we must see to it that proper conditions are observed. And the first and most vital of these is that no company must be allowed to lay any tram or other line along a road unless they agree at their own charges to increase the width of the metalled surface of the road by the width of the largest car which they propose to place on the road—say eight feet. If this condition is not insisted on, we shall see our roads, already far too narrow, seriously reduced. To lay rails and then to run huge cars, often in double lines, as between Kew and Hammersmith, is in effect to produce a most material narrowing of the road. When a road is given over to a tramway company without any increase in its metalled surface, it becomes at once distinctly less valuable for ordinary traffic. By allowing tram-lines to be laid without any corresponding widening of the roads, as has been done hitherto on our suburban roads, we are positively going back, actually making our roads less open to traffic than they were. No doubt it will be said that to demand this increase of the metalled road surface is to lay on the tramways a burden greater than they can bear. I cannot agree. To begin with their prospective profits are very large. Next, the extra expense would not be very serious, because to increase the metalled surface by eight feet could in the case of most of our country main roads be accomplished without buying more land. There is always a strip of land on each side available for widening. To level and metal, and then lay the lines there, would not be very much more costly, and certainly much more convenient to the public, than to tear up the existing road and put the lines there. I venture then to suggest that no local authority should be empowered to give its consent to any scheme for laying lines along its roads unless the company proposing the scheme agreed to widen the metalled surface by the width of its cars. Provision might of course be made for a dispensing power in exceptional and peculiar cases. No one would want to shave off the façade of an Elizabethan

manor on one side or of a Georgian red-brick house on the other in order to comply with the suggestion just made. It can be applied reasonably and yet adequately. The great thing is to apply it and to prevent our roads being narrowed by the tramway companies, who, as we see by the recent applications in Surrey, are intent upon laying their lines in the rural roads within the thirty miles radius of London. The schemes are excellent in themselves, and under proper conditions deserve all encouragement, as tending to disperse the metropolitan population, but care must be taken that roads with tramway lines along them are made wider, and not in effect narrower than before. I note and admit the objection that I am proposing in some cases to hand over the roadside greensward to be metalled. Of course such a loss of pleasant walking ground must be regretted, but it is, it seems to me, a case in which public utility must be the dominant consideration.

CHAPTER XVIII

MOTOR-CARS AND HORSES

BY HERCULES LANGRISHE,
Master of the Kilkenny Fox Hounds

ONE of the chief reasons for the opposition shown to the introduction of motor traffic in this country has been that motor-cars have frightened horses. When bicycles first came in precisely the same thing happened. Everyone, including the writer, who rode the old high bicycle, can well remember the day when it was necessary continually to dismount on account of restive horses, and when cyclists were subject to much abuse from nervous drivers ; but to-day it is an exceedingly unusual thing for a horse, or even the rawest unbroken colt, to pay the very slightest attention to a bicycle.

Automobilists find that provided they conduct themselves properly they do not receive discourtesy from the drivers of horses who are thoroughly the masters of their animals. It is the nervous driver, the man who is frightened of his horse and has neither the knowledge nor the courage necessary for its control, who gives vent to his irritation by abusing motorists.

As one who has driven horses in every sort of harness, and has also journeyed many thousands of miles in automobiles, my opinion is that drivers of horses have very often good reason to complain of want of consideration and discourtesy on the part of motor-drivers, and automobilists who drive recklessly and without proper consideration for other users of the road well deserve the wholesome abuse which is frequently given them.

On the other hand, it is only right that the large class of automobile drivers who show every consideration possible for other users of the highway should not be held responsible because a horse misbehaves itself on encountering a motor-car. Horse-owners must recognise that motor-cars have a right on the road, and, provided that the motor-car be driven properly, its owner must not be blamed because a horse objects to it.

The law as it now stands requires a motor-driver to stop when a man in charge of a restive horse holds up his hand. This, in my humble opinion, is very often a great mistake. What usually occurs is this : a person in charge of a nervous horse holds up his hand, the motor-car is brought to a standstill, but the engine is left running. Now a petrol motor makes ten times as much noise when the car is stationary as it does when the vehicle is moving, and consequently matters are not improved in the slightest ; but if, on the other hand, the car be allowed to proceed slowly, the horse is sure not to mind it half so much.

It has been stated that the horse still retains many of the instincts which were possessed by its forefathers in their wild state. It is well known, for instance, that horses will become terrified with fear when passing a menagerie containing lions, tigers, &c., although the cages holding the animals are boarded round so that they cannot be seen. The odour of these beasts of prey terrifies the horse. This clearly is due to heredity. It is maintained that a horse fears any strange object which approaches it, first slowly, and then stops, just as a wild beast would do when about to spring at its victim. Possibly the horse for this reason fears a motor-car which approaches it cautiously and then is stopped in compliance with the demand of the horse-driver.

If all motorists would drive with consideration there would be no necessity for the law which requires them to stop. But as things are, perhaps the provision which gives the driver of a restive horse power to stop the motor-car is indispensable.

As I have before remarked, horses have grown quite used

to bicycles, and dwellers in cities see that horses are becoming, and in most cases have become, absolutely indifferent to the motor-car. The evil therefore is only a temporary one; but in the meantime it is the duty of horse-owners to take steps to have their animals trained to meet motor vehicles without fear; I maintain, too, that as motor vehicles are daily increasing in numbers, owners of high-couraged horses that are known to become absolutely unmanageable should take special care that their animals are never allowed out on the highway in charge of incompetent lads, who, if a motor-car is encountered, are unable to control them.

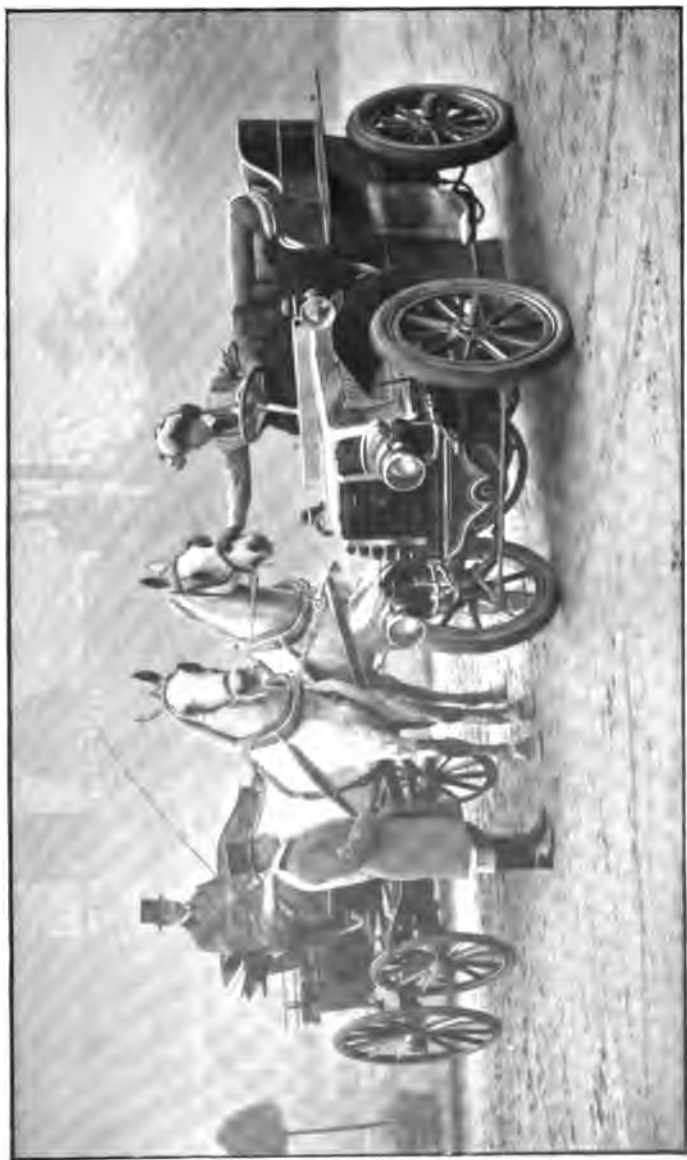
A horse swerving and backing a cart across the road in a village recently as nearly as possible caused the death of a group of four small children who were playing on the pavement in the village. The back of the cart crashed into the wall of a cottage within a yard of the little group.

There was sound wisdom in the recent decision of a court of justice in Paris, where it was held that it is the duty of owners of horses to have them trained to meet motors.

The difficulty which has presented itself has been how horse-owners may obtain opportunities of training their horses to meet motor vehicles. The Automobile Club has already given demonstrations at the Ranelagh and other clubs near London of how horses may best be made tractable, and has advertised these opportunities. If any owner of restive horses will apply to the secretary of the Automobile Club, that gentleman will doubtless be able to arrange that some motorist in the neighbourhood will drive his car to the horse-owner's establishment and there train the restive animals. Members of the Club have done this over and over again, and motorists generally are most anxious to assist in this direction, thus overcoming prejudice.

A well-known nobleman took the precaution to send his horses to Coventry, in order that they might reside in the centre of motordom, and they quickly became used to cars.

The process of training is extremely simple: the horse



ACCUSTOMING HORSES TO MOTORS

should be stood in a paddock and the motor vehicle driven round it in gradually decreasing circles. The driver of the motor should then talk soothingly to the horse, and the groom should also encourage it as much as possible. The horse will follow with his eyes the movements, of the car, and, as a rule, in a little while will allow it to be driven close by without any further signs of fear. The horse should then be harnessed and taken out on the road, the motor-car driven out to meet it, and sent a number of times past it until the animal takes little or no notice. Such treatment as this will be found to succeed very quickly with the ordinary horse which has been trained for road traffic; but special measures might be necessary in the case of some horses which cannot be cured of shying on passing a piece of newspaper, a drain ventilator, or any unusual object.

As regards the relationship between motor-owners and horse-owners, I fully endorse the admirable letter of Sir Henry Thompson which appeared in the 'Times' in 1901, as also the remarks made by Mr. Walter Long, President of the Local Government Board, as follows :—

The people who use cars ought, I think, to remember that it is not sufficient merely to obey the letter of the law, but that they ought to use their motor-cars as they would use any other portion of their property, no doubt for their own advantage and enjoyment, but also with due regard to the comfort and convenience of the rest of the community.

It may not be out of place for me here to make a few remarks *re* the rule of the road. Everyone knows that on vehicles meeting the law is, Keep to the Left. Now Great Britain and Ireland are the only countries in which, so far as I am aware, this is the rule. In France, Germany, America, &c., vehicles meeting keep to the right, and until I took to driving an automobile I never gave the matter a thought, but now the reason is obvious. Take, for instance, a man leading a stallion or other horse on the public highway. The man in charge of the beast naturally leads the horse on his right-hand side. A

motor-car comes in sight. The animal grows more restive than usual, and the unfortunate man is most likely to find himself in the disagreeable position of being jammed between the road fence and the horse. Many may say 'Why shouldn't this man lead the horse from the other side?' but this would be almost as difficult as writing with one's left hand.

CHAPTER XIX

REMINISCENCES

BY THE RT. HON. SIR JOHN H. A. MACDONALD, K.C.B.
Lord Justice Clerk of Scotland

I ASK to be allowed in making a start to go a little further back in reminiscence than the time of the present development of road traction. In my youth I was fond, as I still am, of horse-driving, and took driving tours in the centre of England and of Scotland, and most delightful they were. But in passing through charming country scenes which never meet the eye of the railway traveller, it was impossible to resist an occasional cloud of melancholy when traversing the magnificent old mail roads, often seeing no living person for miles and miles, and drawing up at grand old country posting inns with great empty yards and ranges of rooms above them with closed shutters; once the scenes of life and cheerfulness, but now reduced to a tap-room and accommodation for a lodger or two. The invasion of the rail had swept the country of its traffic, and the Red Lion and the Blue Boar languished, the boots of the Boar and the chambermaid of the Lion, reconciled by joint misfortune and agreeing for once—as Mr. D'Israeli recounted—in denouncing the 'igominy o' railroads.' Who at that time would have believed that at the end of the century, when the railways were congested with traffic, and the public under the tyranny of oppressive traffic rates, a new mode of locomotion would assert itself, reviving the road once more, not only for touring and social life, but also for the benefit of the farmer and the merchant, cheapening and facilitating road traffic both

in town and country, and again giving the highways their place in ministering to public convenience and enjoyment? Yet this is the practical—the socially and nationally important lesson—which is brought to us by reminiscences of the few years in which the mechanical vehicle has been steadily asserting itself, in the face of unreasoning prejudice and pig-headed obstruction. The keenest opposition has come from the squire, the farmer, and the innkeeper, the very people for whom the development of power traction on the roads is certain to work out almost incalculable good.

It has always been so. Although our reminiscences carry us back but a very few years, we know that the idea of mechanical traction on roads germinated three-quarters of a century ago, and took practical shape both in England and Scotland; of this the Automobile Club possesses abundant proof, both literary and pictorial. And history tells how determined were the efforts of the obstructionists of those days to crush out the power vehicle, the opposition being carried even to the length of piling large stones on the road, or cutting ditches across it, to ruin the enterprise, by wrecking the vehicles, even at risk to human life. These tactics were only too successful, and delayed a great public advance in locomotion for more than half a century.

But before the Act of 1896 was passed there were a few automobile Hampdens, who were prepared to face the terrors of the law in order to bring the new locomotion into public notice, and to show to their fellow-citizens what was before them, if only obsolete statutes could be rolled out of the path of progress. And in these reminiscences they deserve to be the first to speak for themselves. Whether there were others I know not, but three I do know, two in England and one in Scotland. First I cull the following from the Hon. Evelyn Ellis. He relates that he first purchased a 'Panhard' 5 h.p. two-cylinder car in 1894 for use in France, and when in 1895 Mr. Shaw Lefevre was about to bring in the Light Locomotives Act, but was prevented by the resignation of the Government,

Mr. Ellis resolved to bring his car to England, in the hope that he might be summoned by the police and thus draw public attention to mechanical transit. An account of one of his drives was given by Mr. Frederick R. Simms, the originator of the Automobile Club of Great Britain and Ireland, who accompanied him, from which I make the following extracts :—

It was delightful travelling on that fine summer morning. We were not quite without anxiety as to how the horses we might meet would behave towards their new rival, but they took it very well, and out of 133 horses we passed on the road only two little ponies did not seem to appreciate the innovation. . . .

Going down the steep hill in Windsor, we passed on to Datchet, and we arrived right in front of the entrance hall of Mr. Ellis's house beyond Datchet at 5.40, thus completing our most enjoyable journey of fifty-six miles, the first ever made by a petroleum motor carriage in this country, in 5 hours 32 minutes, exclusive of stoppages. The average speed was 9.84 miles per hour. In every place we passed through we were not unnaturally the objects of a great deal of curiosity. Whole villages turned out to behold, open-mouthed, the new marvel of locomotion. The departure of coaches was delayed to enable their passengers to have a look at our horseless vehicle, while cyclists would stop to gaze enviously at us as we surmounted with ease some long and (to them) tiring hills.

Mr. Ellis continues :—

I then drove from Datchet to Windsor, and from Windsor to Malvern. I was very little troubled by the police, and they were generally satisfied by my producing my ordinary carriage licence. One old stone-breaker threw down his hammer and threw up his arms in amazement as he saw the carriage approaching him, and said, ' Well, I'm blessed if Mother Shipton's prophecy ain't come true ! Here comes a carriage without a horse.'

Mr. and Mrs. Koosen's enterprise and determination in the face of difficulties form an example for all. Their reminiscences are so interesting from many points of view that no excuse need be made for giving them nearly *in extenso*. It is delightful to find that one of the earliest pioneer endeavours

was prompted by a lady, and when the reader has seen her account of the early adventures of an autocar I think he will agree that 'The Adventures of a Phaeton' were nothing to them, and that Mrs. Koosen has a right to the description of a good wife, the poet making the husband speak of her as

Doubling his pleasures and his cares dividing.

Mr. Koosen says :—

Early in 1895, while travelling in Germany, I saw the advertisement of a motor-car builder with an illustration of a car. My wife said she liked the look of the thing, so I ordered one. I had then never seen a motor-car, and was under the impression that you take your seats, press the button, and the machine does the rest. Well, at last, on November 21, 1895, the thing arrived at Portsmouth Town station.

I had been told in a letter from the maker that to start the engine you had to turn the fly-wheel towards you, which I did until darkness overtook me. The only result was a pair of worn-out gloves.

Mr. Koosen here seems to have found the trouble too much for him, for he says, 'And now I think perhaps it would be better to quote my wife's diary (I don't keep one myself).'

November 23.—Took train to Lee and tried to make our motor work ; wouldn't ; came home at five.

November 24.—Awfully cold ; played with our motor—no result.

November 25.—After luncheon saw to our motor, but didn't get it out of shed.

November 26.—Drove to Lee and took Smith and Penning (engineers) ; Penning spent the day on his back without results.

November 27.—Drove to Lee ; first we drove to T. White & Co. to see about oil, but they gave us five gallons of the stuff costers burn in their flares over their barrows, which messed up our motor, which of course didn't go.

November 30.—Motor went with benzoline for first time ; awfully pleased.

December 2.—Waiting for new oil from Bowley & Son.

December 9.—Drove to Lee at 10 ; motor sparked at once and went well. After lunch started for home in motor-car ; came



'STEADY NOW—IT'S ALL RIGHT!'

round by Fareham ; had lovely drive ; police spotted us ; awful crowd followed us at Cosham ; had to beat them off with umbrella.

December 10.—Policeman called at 1.30, took our names *re* driving through Fareham without red flag ahead.

December 13.—Went drive round common ; tyre came off ; sent her to Penning.

December 16.—Took train to Fareham ; met Hobbs (Hide and Hobbs, solicitors) and Mr. Heckett, and proceeded to Court House ; filthy place ; Hobbs spoke up well for motors (see police reports). Silly old magistrate fined us one shilling and costs, 15s. 7d.

December 27.—Frightened an unattended horse attached to a milk-cart, which bolted and sent the milk-cans flying in all directions.

December 31.—Straps slipped badly, had to get them tightened.

January 4, 1896.—Lost nut off air valve ; pushed home.

January 6.—Stuck again, small tube supplying petrol to carburetter choked.

January 14.—Motor got stuck ; made noises ; sent her to Penning's.

January 19.—Moted to Eastney Lock ; Jack got out to hold unattended horses, and I drove the car into the curb and smashed frame. Shoved into a stable close by.

April 14.—Accumulators gave out, bumped them into Penning's to get charged.

April 19.—Took fresh accumulators out to Lec, but they would not make the engine go, so took them back again.

April 22.—Took accumulators out again and started at once ; did 30 miles for first time in 3½ hours.

April 28.—Heard they wanted motor-cars at the Imperial Institute, so sent our car there.

May 11.—Drove different people about all day in the Imperial Institute.

May 14.—Took Cummins for a drive at Imperial Institute, blew out the asbestos joint of exhaust-box, made frightful explosion noises, and frightened Cummins into fits.

July 18.—By special permission all the cars were allowed to drive to Hurlingham, where we had an excellent lunch and drove round the grounds all the afternoon. On the way back something went wrong with the works, so we took a hansom ; car was shoved back to Institute. Awful !

August 21.—Sold our car and ordered another of same make which we have driven many thousand miles in the last five years.

Who will deny after the reading of Mrs. Koosen's diary that the autocar has given one more conclusive proof of the indomitable character of our race, and of the highest form of human unity, that of husband and wife, being a strength that overcomes all obstacles? Mrs. Koosen will live in history as the first lady of our land to steer an autocar and to have the moral courage to confess that her maiden effort ended in a smash; and Mr. Koosen can pose as the first English martyr of the autocar propaganda, though his suffering consisted only in the extraction from him of one shilling. I do think that if Mr. and Mrs. Koosen's first car can be traced, even though it be to a scrap heap, it should be preserved, and find a place in the museum which must be established for power-traction curiosities.

We had also a pioneer in Scotland, the Hon. T. R. B. Elliot, whose reminiscences of his early days of motor-car driving are as follows:—

My experience of motor-cars dates from 1895, for on December 27th of that year I received my first car—a four-seated Paris-built $3\frac{1}{2}$ h.-p. Panhard phaeton.

Though I continued to use my car frequently months before the Bill passed, the Roxburghshire police undertook not to prosecute me unless a complaint was received from any of the public. Naturally I drove very carefully, and stopped for almost every horse I met, and was lucky enough to escape any complaint.

However, towards the end of February 1896, I thought I should like to break new ground, so, in order to get a clear road, I started one night at 10.30 P.M. for Berwick-on-Tweed—a distance of 30 miles.

Arriving at Berwick at 3 A.M. I proceeded to picnic under the shadow of the Town Hall, and was there soon surrounded by the entire police force on duty—13 men in all. The sergeant took my name, but did not think that any action against me would be taken. However this was not the case, as I was eventually fined the large sum of 6*d.*, with 1*9s.* 6*d.* costs, for 'using a horseless carriage without having a man on foot preceding it.'

It is interesting to notice that of my three selected pioneers the only one who was not haled before a judge was the devoted martyr, who hoped, by getting himself convicted, to call attention to the absurdity of the law. Mr. Ellis escaped, while Mr. Koosen and Mr. Elliot were both fined. It is also worthy to be noted that the fines contrast in a marked manner with those of more recent times. One can imagine the consultation on the J.P. Bench. 'There is no need to be hard on these lunatics.' 'Such absurdities as motor-cars will never make their way in this country.' 'The idea of any sane man using such a thing, when he can get a horse, is ridiculous.' 'Oh, fine the idiot is.,' &c., &c. Now, it is stop-watches, measured miles, policemen in disguise as yokels, 10*l.* and costs—the strongest possible proof of its being realised that automobilism is a permanency which must be reckoned with.

Circumstances did not admit of my being a pioneer myself, but I lay claim to have shown my interest early. I was present at both the Exhibitions, one at the Crystal Palace, and the other at the Imperial Institute, and at an early stage I engaged a seat to go from the club to the Crystal Palace for a competition there. Looking back on these three events now, I feel justified in saying that I have something of the doggedness shown by other pioneers, for anything more disheartening than my experiences it would be difficult to imagine. I took a considerable party down to Sydenham, and found hunting for autocars to be like seeking the proverbial needle in the bottle of hay. At last we found a shed in which were three or four cars and three or four men, machines and mechanics looking equally melancholy and unbusinesslike. After a long wait one car came out and went along the terrace. How it did jingle, and how it did smell, and how it did smoke! My party did not turn and rend me, but when I dilated on the future of this new mode of locomotion, their eyes looked past my head expressionless, and their lips uttered no sound. I could only, on the way back by train, silently chew the cud of discomfiture, hugging the thought in my heart that the day was soon coming when my

friends would find that it was quicker to take the road by autocar to reach the Crystal Palace than to rely on the time-tables of any railway professing to carry passengers to that fairy-land at the breakneck time-table speed of eighteen miles an hour.

I was not prepared to face another party of friends, so I went to the Imperial Institute Exhibition alone. Not much encouragement there. A good many carriages on red baize platforms, but so beautiful in paint and varnish that one had an uneasy feeling that they had never known the road, and that no amount of handle labour would bring a grumble of life out of them. One car was going about, which I confess would have had more of my respect had I known that it was the car of the never-giving-in Mr. and Mrs. Koosen. After ten minutes I left the place much in the mood, though not I hope using the language, of Mr. Tittlebat Titmouse when he turned from the railings of the drive in Hyde Park on a certain Sunday afternoon.

These were the days when it was thought practical, as Mr Butler informs me, 'to turn out a car of one-and-a-half horse-power to carry two passengers, and luggage, spare parts and tools, consequently we had to get out and walk up all the hills, steering by the side, while the engine took the car up by itself; where the hills were very steep we had to help the engine by pushing the car up.' I think, as I am quoting from Mr. Butler, I may conveniently add his general remarks:—

German chains, links stretched and broke very often, and a common thing for a chain to come off; the chains being covered with black lead the hands were always black, and petrol often had to be used to clean them. Tyres German, solid ones, very often came off, and we had to wire them round and round to the wheel the best way we could, to keep them on. Soldering came undone, belts used to break and stretch, nuts came off as there were no pins through the bolts, &c.

Many a time, when miles from an inn and very hungry, would a breakdown occur, but afterwards took precaution never to go out on a car without a large flask of dry sherry and a tin of Bath Oliver biscuits.



'THOSE HORRIBLE MOTORS!'

I shall here mention an incident which occurred to myself, illustrative of the maxim that in matters sporting you should not prophesy unless you know.

My third adventure, of which I spoke above, was an attempt to realise my prophecy about certain results of a competition in speed between the autocar and the South of London railways on the route to the Crystal Palace. A car engaged for the party came whirling round into Whitehall Court in great style, onto which the secretary, myself and my son, whom I wished to introduce to the joys of automobilism, mounted gaily. We started and rounded into the Embankment, driven by the principal engineer of a company that shall be nameless. A cautious driver evidently, as the pace showed. Too cautious apparently, as a further diminution of pace indicated. 'Give him the w'ip, Gov'ner,' from the delighted cabby. Engineer's face a study. Steers to near side; motion ceases. Crowd gathers; passengers try to look happy. 'Don't 'it 'im, sit on 'is 'ead!' shouts the red-faced 'bus-driver. Passengers desert stranded wreck. End of experience No. 3. Yet, like Mr. Ellis, Mr. and Mrs. Koosen and my compatriot Mr. Elliot, I am as keen as ever.

I have this excellent little story from Mrs. Coleridge Kennard:—

A country parson, without any previous experience, takes it into his head to turn motorist, buys a second-hand Benz Ideal, and calmly states that he intends to be his own mechanician. Imagines cars run without any attention. Is surprised when informed they need petrol, and lubricating oil. Begins operations by fetching a bicycle oiler and giving the piston a niggardly drop of cycle oil. When told this will not answer, is greatly astonished, and expresses his opinion that there is too much oil at one end, too much grease at the other. Has innumerable difficulties, and blames the car for them all. Says his father made chronometers, so he quite thought he should be able to keep a motor in order without much trouble. Finally, after a series of disasters, consults expert opinion, and innocently puts the following query, after complaining that he cannot get his car to go anyhow.

'Oh! by-the-by, I filled the petrol tank up with water by mistake, I suppose it does not matter?'

Mr. Carr relates the following :—

An enthusiastic friend of the designer of a new motor tricycle eagerly sought an opportunity of personally testing the wonderful machine, which was started and stopped by raising and lowering a back wheel. Off she bounded with a scuffle, and flew round the track. All went well until the E.F. thought he had had enough, when he was seen to be busily engaged with the lever.

As he passed his friends he shouted, 'The lever won't work!' Roars of laughter rent the air. There was nothing for it but to sit it out till the supply tank was exhausted; and this kept our friend fully occupied for the space of an hour and a half. A good non-stop record, no doubt, but apparently more enjoyed by the spectators than by the performer. Report hath it that he had to be assisted home.

Here is a confession by Mr. Sturmev :—

The engine sounded as if pulling all right, but there was manifestly something wrong, so on went the overalls followed by a dive under the car. Suddenly one of the occupants of the car remarked, 'Why, you've got your brake on!' and so I had.

My own most vivid experiences of breakdown, which strongly illustrate the truth that the blame does not often lie with the vehicle but rather with those who turn it out, or who drive it, must be told at the expense of more than one important official of the Automobile Club. The scene on both occasions is the London-Uxbridge road, the driver on both occasions the secretary of the club, assisted on one occasion by the honorary secretary as honorary mechanic. Let me take the last first. Starting hopefully from Whitehall Court we careered along until, just opposite the Wellington statue, the car said 'No further.' Whether it was 'I won't' or 'I can't' we did not know. The imperturbable Johnson said nothing, but with great presence of mind turned round and gravitated to the front of the Wellington Club. All the secretarial skill addressed itself to trace the mischief. Suddenly, the sad word of a penitent

came from the amateur mechanic on the back seat, 'Oh, I forgot to turn on the petrol.' Off again, and no adventure until, on clearing the town, the high speed was put on. Presently off flew the belt, when it was seen that it had been patched many times, and that badly, and being fastened with riveted holders was ill able to stand being joined up again. Another start made, and we approached Uxbridge with joyful anticipations of tea. Alas, just outside the town our engine refused to move. Again the contrite voice of the amateur mechanic behind intimating that he had omitted to turn on two of the lubricating taps. Engine hot, and patience the only cure.

My second experience was in the same car. I started for Gloucester with the secretary for the County Council demonstration. In answer to my question the assurance was given that the firm which provided the car had solemnly vouched that all spare parts were there except those necessary to rebuild the whole carriage. We had not gone far when it came home to us that we were going on one cylinder. Examination revealed a plug destroyed and exhaust-valve broken. Any spare valves? Tool-boxes and lockers turned out on the road. Nothing like a valve to be seen. Meanwhile I had got out a new plug. On applying it to the hole it went down out of sight. It was like putting a lady's hand into Daniel Lambert's glove. Nothing for it but to let the car descend a hill by gravitation and steer it on to the grass at the gate of a field. Returning to Uxbridge we relieved our minds per telephone to Long Acre, and got the assurance that a man was being despatched by next train with valves and plugs. We went to each train that came in. No man, no plug, no valves. Crestfallen to bed. Next morning, on reaching the station to go on by train, found, to our disgust, that a parcel had come the night before, but without a man, and that we could have got all put right that night. Since then I have formed the confident opinion that if Mark Tapley had lived in the early days of autocars, he would have lost his character. Nevertheless, such adventures have their uses. They teach valuable lessons.

Reminiscences would not be complete without a few words on two common troubles that afflict the (motoring) just—side-slips and punctures. Both of these would supply a volume of the Badminton Library in the way of anecdotes tragic and the opposite. As regards side-slips I shall mention only one. Mr. Edmunds was driving along Victoria Street, and intended to pass between two vehicles, when suddenly the guaranteed non-stop butcher's cart was driven by the unspeakable butcher's boy right into the vacant space. Mr. Edmunds did his best to pull up. The car did her best to turn round, and succeeded in going round all the points of the compass, all other vehicles flying before her pirouetting form. As she came round in went the clutch, and she rode gaily forward along the cleared road. Lady sitting behind leans over to Mr. Edmunds, and says sweetly, 'How delightful!—that was a most marvellous piece of steering. I wouldn't have missed seeing such a feat of skill for anything.'

Autocar punctures form the one exception to the rule against implicit belief in travellers' tales. No one can exaggerate about them, and no one would if he could. May I slightly alter the ancient prophet's word, and say, *à propos* of the pneumatic tyre, that 'man is born to trouble as the 'dust 'flies upwards'? The autocarist who runs on pneumatic tyres has *atra cura* ever sitting behind him in his chariot. At any moment his wheel and his spirits may go down literally 'like a shot,' and the gay spark who is beating records in speed and in dust raising, may find himself trying to look happy in the middle of a crowd that gapes, and it may be jeers, and in the English sense shows itself the profane vulgar, while he is toiling out his soul, and blowing up his car in more senses than one.

As a contrast to this let me give my experience when bringing my car from the builders in Paris; 150 miles had to be run in one day from Beauvais to Dunkirk before 8 o'clock to catch the steamer for Leith. At St. Omer I found a carpet stud up to the head in one tyre, and at another halt I found a scar about an inch long in the other driving tyre. Each of these would have made it impossible for us to cover the 150 miles in time had

the tyres been pneumatic instead of solid. We drove on quite merrily, and after the car had reached Scotland and had been driven to Stirling, I got a cycle repairer to clean out the scar and fill it up with rubber. In doing so he probed on to something, and after working like a dentist at a stiff stump, he punched out a flint as big as a thumb-nail and more than an eighth of an inch thick, which was buried in the tyre, completely out of sight.

For the sake of any readers of Badminton who have never tested the fascinations of autocarism, I should like to recount some incidents which show that when the motorist's blood is up he will go through hardships equal to any that the most ardent votary of any sport will face, and these recitals give proof how motoring stimulates energy and invention.

Mr. Graham White gave an illustration on the 1,000 mile tour of what an autocarist will do rather than give in. I suppose it is the first instance of a human tiller being used for steering. On this run he on one occasion got down for a moment, asking his friend to steer, which the friend did by promptly running the car off the road and breaking the steering gear, putting the car in about the most hopeless disablement conceivable. There were many miles still to be traversed, and Mr. White accomplished the run by standing on the front of the car, and working the steering directly with his foot, thus bringing her through the crowded streets of Newcastle. I cannot tell you how he did it, but that he did it is certain.

Another case was that of Mr. Rolls driving a car from Paris in 1900. The story tells of the following mishaps : joints of waterpipe gone, bad junction to be replaced, bad cut in tyre of off front wheel ; chain loose, burst of back tyre, mackintosh loose and wound up in shreds on pump, leaking cylinder, whole upper ends of cylinders red-hot, pump jammed, leaks in radiator pipes, ignition tube burst twice, oil on the brakes, another tyre burst.

These were surely trials enough to break the back of resolution, but what the Anglo-Saxon and the Gael will do and dare can be appreciated when I mention that all these troubles

were encountered in mid-winter, sometimes in blinding snow and always in well nigh Arctic frost, most of them happening between dusk on one day and six in the morning of the next day, with icicles hanging from hair and beard, with the cold so intense that Mr. Hutchinson, from whom I quote, says that the following coverings were 'none too much,' 'a warm knickerbocker suit, a Cardigan jacket, a waterproof hunting-apron, a heavy double-breasted ulster, a waterproof cape, and a cap with ear-flaps, so that only the eyes and nose were exposed.' The proceedings involved two hours' stop at one place, burning waste soaked in petrol under the radiators, Mr. Rolls on his back mending leaks, while the water trickled all over him and down his sleeves and freezing till his leather coat was stiff with ice. Yet after all this the party, when they had set themselves up at a village with some bread and cheese—and, I presume, though the chronicler does not say so, with some *vin du pays*—decided to make a start once more, at 2.30 A.M., and reached Havre only in time to go to bed at six in the morning. No wonder foreigners think the English insane.¹ But it is a thing to be thankful for that it is an insanity which has its compensations, for not only in sport is Great Britain a living witness that 'dogged does it.'

There is no space to write of the humours of automobilism, but as a kind of savoury the following must be quoted.

Colonel Magrath says :—

'In one of my first drives I met an elderly woman on a quiet road, proceeding to market. She got dreadfully startled at seeing the car, and when she arrived in Wexford told everyone that she met a carriage from the other world, with a horribly ugly demon driving it, and she knew at once that the carriage was sent to take her to hell, but, thank God ! she had sense enough to make the sign of the Cross, when carriage and ugly driver vanished.

I presume in its own dust.

¹ Mr. Rolls thinks it is remarkable that I should have used this expression, as the hotel-keeper who received them at Havre, and who spoke a little English, said to the party, 'You English must be very "insanitary" to travel by road on such a night.'

Lord Edward Churchill relates how he got a motor-car to please his daughter—another instance of the ladies taking a lead, and curiously enough, as in the other case of Mr. and Mrs. Koosen, the gentleman, when he is too sad for words, refers you to the lady's diary. She describes how, having broken down, they had to

'wait ages for that horse, but at last a cart-horse turned up and was tied to the car with ropes. The man thought he would ride, my father would steer, I would keep things cheerful, and we would trot home. We did reckon without our host, and we may thank Heaven that horse was quiet. The man whacked it and it suddenly started on faster, so the car went on with a jump, the horse slowed down, and the natural consequence was the car ran hard on to the horse. The poor dear beast thought it its duty to hold back, so sat down on the dash-board and did not move. Of course it broke in half, my father in the agony of the moment having forgotten to put on the brake. Then I could have cried, but I did not, and there was more to follow. We suggested that the man had better walk as we had had enough of trotting. . . . Then the horse got its leg over the rope and wound the rope round the wheel, then the wheel ran on its hoof, but it did not mind, and I was too sad to cry then, so I tried to laugh. We got home in the dark at eight o'clock. The boys and men in the village were insulting, and called out "Whoa Motor! that's the way to lead it whome," &c. Even my father smiled then. He said it was a beastly thing, and talked of selling it and a few other remarks of that sort.'

Nevertheless he too is still an ardent votary of the sport.

No reminiscences would be complete without a notice of the Thousand Miles Trial of 1900, which would by itself supply material for a volume. The demonstration of interest by the public was remarkable, and the strongest expressions of good will came from the very old people of both sexes. This was much remarked on at the time. I attribute it to the fact that these aged persons had been young when railways began to cover the country, and doubtless had heard them spoken against on all hands, prophecies made that they would ruin the country, denunciations thundered against them from all who had to do with

horse traffic, and frantic efforts made to keep them from being sanctioned. These people had lived to see the folly of all such proceedings and predictions, and therefore, their minds were free to wish success to a new mode of traffic, which might be expected to bring many of the benefits of quicker and cheaper transit past their own doors by the road.

Another fact which made a strong impression upon me was the small fatigue of long road journeys, as compared with horse-drawn travelling. I suppose Colonel Magrath and I were the two oldest men who made the tour, and we rode on a car having solid tyres. Yet I cannot recall having felt any sensation of weariness even after the longest runs (e.g. 125 miles per day) and we both came to the end as fit, if not more fit, than when we started. Another remarkable feature of the event was that, although it was the first demonstration of the power vehicle on a large scale, so many of the cars completed the whole journey, notwithstanding that many devices which were still in the experimental stage must have been on trial. And of the breakdowns which did occur, a very large proportion were vehicle failures, and not machine failures. It was not surprising that with little experience of vehicles travelling on ordinary roads at higher speeds than was possible with horse traffic, and with greater dead-weight, and with the power applied direct to the wheels instead of by haulage, defects in frames and axles and wheels should show themselves, until experiment had reduced the requirements to formulas that might safely be followed.

Of the kindness with which we were received everywhere, we shall all cherish a delightful recollection. But I think everyone who took part in the tour will join with me in saying that what will be most remembered was the extraordinary success of the organisation, by which so great an undertaking was carried on without a hitch. The labour, the forethought, and the tact that must have been put out cannot be measured. Mr. Claude Johnson, Secretary of the Automobile Club of Great Britain and Ireland, who originated the scheme, and

his subordinates deserve the place of honour in the history of Automobilmism in this country up to the present time, and they will be wonderful contestants that succeed in wresting it from them in the future.

And now, as a last word, let me say what I believe will be said by all who have enjoyed this new sport : that we value it for two reasons. The one is that it will open up to the community many advantages both social and commercial. The other I feel very strongly. It is that it extends in a delightful manner the range of one's personal friendships, and promotes pleasant social intercourse of both sexes, in healthy enjoyment of fresh air and cheerful surroundings. May we continue to be a friendly guild. Pioneers must always keep close together. Union overcomes difficulty, and our motto should be

Double the pleasure that friendship doth divide.

CHAPTER XX

SOME POINTS OF LAW AFFECTING THE OWNERS OF
MOTOR VEHICLES

BY ROGER W. WALLACE, K.C.

Chairman of the Automobile Club of Great Britain and Ireland

As every person interested in motor carriages knows, until the passing of the Locomotives on Highways Act of 1896, every mechanically driven carriage had to be preceded by a man on foot with a red flag, and proceed at a pace resembling that of an ox waggon. But now we may, if our vehicle be under a ton and a half, move at the pace of an average horse, that is to say at twelve miles an hour. Whether it be at all necessary in the open country to so limit the rate of progress is a matter on which opinions still differ, but owing to the efforts of the Automobile Club, public opinion is rapidly changing in favour of an alteration in the law.

This matter of speed, however, has from the first been a burning question between motor-owners and the general public as represented by the police and magistrates. In addition to the limit of twelve miles an hour the Local Government Board, under the authority conferred upon them by the Act of 1896, have made the following regulations :

The driver of a light locomotive—

1. Shall not drive at any speed greater than is reasonable and proper, having regard to the traffic on the highway, or so as to endanger the life or limb of any person or to the common danger of passengers.

2. If the weight unladen of the light locomotive be one ton

and a half, and does not exceed two tons, he shall not drive the same at a greater speed than eight miles an hour, or if such weight exceed two tons, at a greater speed than five miles an hour.

The second of these regulations is clear to everyone. As regards the first, every respectable driver would agree to the spirit of the regulation, but a certain surprise comes upon one when first learning what the decision of the court is as to its meaning. It has been laid down that both expressions 'having regard to the traffic on the highway' and 'to the common danger of passengers' have no reference to the fact of there being any traffic or passengers on the road in the vicinity of the car. In one case, the *locus in quo* was a street in Esher, where of course there might have been traffic, though the evidence seemed to point to none being there at the time. These decisions appear most unfortunate, for any driver would consider himself perfectly justified when in the open country, and seeing the road clear, in going at the limit of twelve miles an hour, but it would seem that any policeman noticing him could still summon him under this subsection. Although these decisions stand, yet I can hardly think that a conviction under this subsection if there were not also an offence against the twelve-mile limit could really be upheld in the case I have suggested. The Courts have recently intimated in the case of *Gorham v. Brice*, published in the 'Times' of March 13, 1902, following other cases, that it is not much use appealing to the High Court of Justice, and that what appellants really want is a change in the law. In this case the Lord Chief Justice (Lord Alverstone) said he could not understand the motives with which such appeals were brought or what automobilists thought to gain by suggesting there was no evidence as to speed, when, as in practically every case, they did not like the findings of magistrates. He further stated that it was possible the magistrates might have come to a wrong decision, but the Court had no power to interfere with their findings of fact.

Any vehicle which draws another is not under any

circumstances to go at more than six miles an hour. Owners of tricycles with trailers need not be afraid of this regulation, for the combination is held to constitute one five-wheeled vehicle, so that they come under the ordinary provisions.

Motor carriages have to carry by the regulations of this Act, in addition to a white light on the right side showing in the direction the carriage is going, a red light showing in the reverse direction.

There are several questions which naturally arise as to the law affecting owners and users of motor carriages on which there is some doubt. I have endeavoured in the following paragraphs to give an answer to some of the questions that are most frequently asked, and I hope these answers will be of some utility to fellow-automobilists.

The first question is one which applies to almost all owners, and is, whether it is necessary to pay a tax on motor mechanics as male servants or whether they can be classed as engineers and escape duty.

On the paper which is sent out by the Inland Revenue authorities every year will be found an extract from the Act 32 & 33 Vict. cap. 14, s. 19, which regulates the imposition of the duty payable on male servants. Apart from the end of the classification, which says that the master is liable to pay duty on all domestic servants, there is included specifically 'coachmen.' While we are not in the habit of calling our mechanics coachmen, yet there can be no doubt that a coachman is a man who drives a carriage, and although he may only be employed part of the day to drive the carriage, yet so is any other coachman who drives horses. It seems, therefore, quite clear that the duty must be paid. There is an idea prevalent amongst many people that it makes a difference whether the man wears livery or not; but this is a delusion; the only difference it could make would be to show more clearly that the man is a domestic servant.

Another question relating to taxes is what tax must be paid on various motor carriages?

Most of the motors with which we have to deal are carriages with four wheels, and these must pay the ordinary carriage tax, which is for a carriage with four or more wheels, to be drawn or propelled by mechanical power, the sum of 2*l.* 2*s.* 0*d.* There is also to be paid, under the Locomotives on Highways Act 1896, an additional duty if the weight of the locomotive (i.e. the motor carriage) exceed one ton unladen, but do not exceed two tons unladen, 2*l.* 2*s.*, or if the weight of the locomotive exceed two tons unladen, 3*l.* 3*s.* 0*d.* It should be noted that unladen in this Act means without including the weight of any water, fuel, or accumulators used for the purpose of propulsion. As a matter of detail it may perhaps be mentioned that the latter licences have to be obtained from a collector of Inland Revenue or a Supervisor of Inland Revenue. The lighter vehicles pay as follows :— A quad is a four-wheeled carriage, and, therefore, pays as above, and so also does a tricycle used with a trailer, being classed as a five-wheeled carriage. For tricycles and bicycles the licence costs 15*s.*, they being classed as light private carriages, the definition of which includes ‘any carriage propelled upon a road by steam or electricity or any other mechanical power.’ Those whom it interests will find a report of a case tried on the question of whether a carriage licence should be taken out for a motor tricycle, the decision being in the affirmative, in the ‘Autocar’ of May 26, 1900.

There is a doubt current as to whether a master is liable to his driver under the Workmen’s Compensation Acts. This is not so, the first Act, that of 1897, referring to servants in a factory and certain other employments ; although some places which to the lay mind would scarcely seem to be included in the word ‘factory’ have been held by the judges to be so classed, there seems no possibility of a motor-car being held to be a factory. The Act of 1900 only extended the application of the former Act to the case of agricultural labourers. While on the subject of accidents it may be mentioned that insurances are procurable which will indemnify both the

owner and anyone who may be driving him against injury or death.

There are other liabilities to which motor owners are subject in the same way as are all users of the highway. For instance, a child may be run over and injured. The law applicable to such accidents in the case of motor carriages is no different from that which applies to all other carriages—that is to say, the owner is liable both when driving himself and in any case in which his servant is driving on his master's service, but only when the accident is caused by an improper or negligent use of the highway, and when the injured party is not himself guilty of negligence which causes the accident. Against the above and other liabilities it would be well for owners to insure; a list of the best offices can be obtained by communicating with the Secretary of the Automobile Club.

Passing another vehicle on the wrong side is always a dangerous proceeding, as if an accident occur the fact may weigh heavily against the motorist. It is better to use patience and insist on the driver of the other vehicle pulling in to his proper side.

It is perhaps poor comfort to the tourist to know that he can if he like to wait long enough in the neighbourhood, summon any person who wilfully obstructs the highway, but a threat of issuing a summons might have some effect upon a carter in a country road who refuses to allow room for a car to pass.

As the writer stated at the beginning of this chapter, efforts are being made by the Automobile Club to secure an alteration of the law, and it may be as well to state some of the proposed changes. It is first of all suggested that there should be no limit of speed mentioned in the principal act, and that the reference thereto should be deleted. All rules as to rates of speed, it is proposed, should be left in the hands of the Local Government Board.

For the statutory rules and orders it is proposed to substitute the following :—

(1) He shall not drive a light locomotive at any speed greater than is reasonable and proper, having regard to the traffic at the time on the highway or so as to endanger the life and limb of any person at the time on such highway.

The words 'or to the common danger of passengers' are proposed to be omitted owing to the decisions above referred to.

(2) If the weight unladen of a light locomotive does not exceed two tons, then the limit of speed of 14 miles an hour provided by Section Four of the Act shall not apply to such light locomotive provided that it is fitted with efficient brake-power, except under the following circumstances, when Section Four of the Act shall apply.

- (a) When a light locomotive is passing through towns, villages, or crowded places.
- (b) When the light locomotive is meeting any horse or cattle driven upon the highway.
- (c) When the driver is not able to see that the highway, or any road or other highway joining therewith, is unobstructed for a distance of fifty yards.

In return for these concessions the Club suggest that a regulation should be imposed requiring the proper identification of all cars which are constructed to travel at a greater speed on the flat than $18\frac{1}{2}$ miles per hour.

With regard to the administration of the Act it is also proposed that there should be an appeal on questions of fact from the decisions of Justices of the Peace similar to that which is allowed under the Married Women's Summary Jurisdiction Act, which has been found to work very satisfactorily. Other alterations have been proposed with reference to the tare limit, width of tyres, &c., with which it is unnecessary to deal with here in detail.

In conclusion the reader should carefully peruse the Act and regulations which are printed in the Appendix, and which require no further explanation.

CHAPTER XXI

AUTOMOBILE CLUBS

BY C. L. FREESTON

To say that the history of automobilism is that of its clubs is nearer the literal truth than a lapse into exaggeration. The debt which the sport and industry alike owe to these bodies, in every country where they have been formed, is incalculably great, and, however far the aspirations of the enthusiast may yet be from their ultimate fruition, the present stage of progress would not even have been within measurable reach but for the fostering care of the Automobile Clubs. Not in name merely, but in fact, they have been *Sociétés d'encouragement* throughout, and by trials and demonstrations in Great Britain, and races and hill-climbs abroad, have established the claims of the motor vehicle to the attention of the world.

The United Kingdom has been particularly fortunate in its Automobile Club, the exertions of whose numerous committees have been continuously arduous and self-sacrificing ever since its formation in 1897. By legitimate methods of propagandism it has gradually worn down a considerable amount of the prejudice and opposition to a new movement that were inevitable in a conservative country, and by its demonstrations of the practical utility of the motor vehicle it has entirely removed the evil but long-remaining impression of the appallingly abortive run to Brighton on November 14, 1896. Not the least important of the Club's services, moreover, is its conversion of the public, and, it may even be said, of the Local Government Board, to the uselessness and ineffectuality of

the twelve miles an hour limit, the ultimate repeal of which is confidently awaited.

A brief retrospect of the Club's history may not be unacceptable to the more recent recruits to the pastime. In the summer of 1897 a few pioneers met, and mutually agreed to form an Automobile Club. On the 10th of August the Club was formally constituted. Premises were then acquired at 4 Whitehall Court, S.W., and were inaugurated on December 8. By this time 163 members had enrolled themselves, and such good progress was made that by the end of 1898 the membership had attained a total of 380. But already these early devotees were called upon to substantiate their faith, for the revenue of the Club was drained by three extraordinary sources. These were an initial expenditure of 540*l.* in the establishment of the Club; law costs amounting to 148*l.* 6*s.* 4*d.*, owing to a dispute about its title; and the placing of 1*l.* on deposit from every subscription received, in accordance with the articles of association. A guarantee fund, however, was formed, and amounted to 1,521*l.* at the close of the year. Mr. Roger W. Wallace, K.C., was the first chairman, and still worthily upholds the office; Mr. Evelyn Ellis and Mr. Frederick R. Simms (the originator) were elected vice-chairmen, with Mr. Frank H. Butler as Hon. Treasurer, Mr. C. Harrington Moore (the Club's first organiser) as Hon. Secretary, and Mr. Claude Johnson as Secretary.

From the outset the Club became an active and virile force in the automobile movement. Its fixture list comprised tours and week-end runs, club dinners (which had been previously founded by Sir David Salomons, Bart.), lectures and discussions, and general meetings. It exerted its influence, with others, in preventing the introduction of vexatious clauses affecting motor vehicles in Bills seeking powers for local authorities; it assisted in opposing the Westminster Tramways Bill; and it compiled a list of motor-spirit stores. In July of the same year, moreover, an amalgamation was effected with the Self-Propelled Traffic Association, and the Club thereupon became the

only recognised authority on automobilism in the United Kingdom.

In the following year the membership grew apace, and on December 31, 1899, the roll was as follows:—Founder members, 287; life members, 21; ordinary, 187; ordinary town, 47; ordinary country, 41; supernumerary, 3; a total of 586. The chief event of the year was the holding at midsummer of a show of motor vehicles, in the Old Deer Park, Richmond. Races, time tests, and hill-climbing trials were conducted in connection with the exhibition, which extended over a period of eight days. The labour of organisation had been considerable, the show committee having held no fewer than forty-three meetings; but public prejudice was still strong enough to make the undertaking a financial failure, and it resulted in a loss of no less than 1,600*l*.

More satisfactory were the other functions of the year, for in addition to several tours a series of brake tests was carried out on Petersham Hill, in the presence of Local Government Board inspectors; an exhibition of motor vehicles was held at Dover, in connection with the meeting of the British Association; and a conference of manufacturers of motor waggons was organised to discuss the suggested raising of the tare limit. The anniversary of the coming into operation of the Locomotives on Highways Act, 1896 was celebrated on November 14 by a run to Sheen House.

Greater activity than ever characterised the year 1900, during which the membership rose to 710. In four Club tours alone a distance of 1,196 $\frac{3}{4}$ miles was covered, while the year will ever be memorable for the organisation of one of the most remarkable demonstrations in the history of locomotion. This was the famous Thousand Miles Trial from London to Edinburgh and back; it was strikingly successful, and did much to remove the public apathy. Day exhibitions of the competing vehicles were held in seven large towns *en route*, and a week's exhibition of the successful cars followed at the Crystal Palace. A trade show of motor-cars under the ægis of the Club, but

managed by Messrs. Cordingley, was also held at the Agricultural Hall, from April 14 to 21. Numerous house dinners and discussions were arranged during the year, together with three 100-miles trials on the Oxford Road, and electric trials at Chiselhurst. Automobile gymkhanas took place at Ranelagh and Sheen House, and a fête at the Crystal Palace. The issue of a Club gazette, under the title of 'Notes and Notices,' was begun, of which twenty-three numbers have been published, while eight branches of the Club were established throughout the United Kingdom. As a preliminary to an extensive campaign in 1901, moreover, demonstrations of motor-car efficiency and control were held before the County Councils of Warwick and East Suffolk, in consequence of a hostile agitation having been set afoot in favour of the reduction of the speed limit to ten miles an hour. In several directions during the year the Club was able to secure a reduction of absurd tolls levied on motor-cars, and the removal of objectionably restrictive clauses in a corporation Bill.

In 1901 the conversion of the County Councils was successfully taken in hand. Towards the close of the previous year a letter of twenty-six pages of printed matter had been forwarded to 4,412 County Councillors and sixty-five clerks to County Councils, who were now invited to attend a big central demonstration in the metropolis, or to arrange for demonstrations in their own locality. Cars were sent to various parts of the country for this purpose in the early part of the year, pending the great demonstration in June. The last-named function extended over three days, between three and four hundred County Councillors being driven on cars to Sheen House, and there entertained to luncheon before the return to town. It is certain that the ease with which the cars could be controlled was a complete and gratifying revelation to the majority of the visitors. The Chief Constables of the English and Welsh counties were also approached by the Club in the frank and friendly manner which has characterised its propagandist efforts throughout. They had been circularised in the

same way as the County Councillors, and were also invited to a demonstration in London on February 26th, which was well attended. Following a drive to Sheen House and back a conference with the Chief Constables was held at the Automobile Club premises, when the visitors were afforded every opportunity of stating their views. A demonstration was also given at Leicester on June 29th, before a large body of municipal and county engineers assembled for their annual conference. A noteworthy achievement of the year was the raising of the speed limit in Scotland from ten to twelve miles an hour, the Secretary of State assenting to that alteration upon representations from the Club. In May the Motor Union was formed in connection with the Club, as a defensive association for the protection of the civil rights of members. A special Legislation committee was also appointed in August, with two of his Majesty's judges among its members, to consider the provisions of a new Bill for the regulation of motor vehicles. The Club held three quarterly hundred miles trials, two consumption trials, two hill-climbing trials, and a week of test trials at Glasgow. Several tours and runs also took place, the anniversary run to Southsea on November 16th being an enormous undertaking, considerably over a hundred cars making the journey, notwithstanding a dense fog at the start. The year closed with a total membership of 1,154.

Very early in 1902 the Club's activities were displayed in the shape of an important trial of brake-power in Welbeck Park, in the presence of the chief engineering inspector of the Local Government Board. The results were dramatically effective, even very heavy cars being stopped inside two lengths at a speed of eighteen miles an hour. At the annual meeting of the Club on February 27, it was shown that the finances were in a satisfactory condition, notwithstanding the heavy expenditure on the County Council campaign. By a decision to migrate to new and much larger premises at 119 Piccadilly, the Club entered upon a new chapter of its history.

Of foreign automobile clubs the number is already considerable ; if the various provincial clubs are taken into account a total of about one hundred and twenty is attained. The most representative organisations of Europe and America are enum-



The Automobile Club of Great Britain and Ireland, 119 Piccadilly

erated below, the details as to their achievements and respective constitutions being compiled from particulars supplied by their officials and from other available sources.

FRANCE.—The Automobile Club de France, which was founded in 1895, is not only the oldest of automobile clubs, but it is also the largest and the most influential. Its headquarters in the Place de la Concorde, Paris, are on perhaps the finest site in Europe, and are quite palatial—in fact, they constitute one of the handsomest club-houses in the world. An elegant private theatre, a spacious *garage* and pleasant roof-gardens are among the special features of the establishment. The French Club has two honorary presidents, M. Marcel Deprez and M. Georges Berger. The active president is the Baron de Zuylen de Nyevelt de Haar, who has ever been foremost in furthering the interests of the Club and of automobilism generally. The vice-presidents are the Marquis de Dion and M. Henri Menier. Other officers are as follows: technical secretary, the Comte de la Vallette; treasurer, M. André Lehideux-Vernimmen; members of the administrative council, MM. Abel Ballif, Comte de Chasseloup-Laubat, Edmond Récopé, and Gustave Rives; secretary, M. Chas. Ward. The annual subscription is 200 francs, and there are over two thousand members. Visiting members of the Automobile Club of Great Britain and Ireland may avail themselves of certain privileges of the club-house in the Place de la Concorde for a period of four days on producing a special card of introduction from their own Club. With regard to the organising and propagandist work of the Automobile Club de France, it may be said that this has chiefly been confined to the promotion of races, the results of which have exerted a widespread and potent influence in demonstrating the capabilities of the motor vehicle. The races held under the immediate direction of the Club have been as follows: 1896, Paris-Marseilles-Paris; 1898, Paris-Amsterdam; 1900, Paris-Lyons (Gordon-Bennett Cup), Paris-Toulouse; 1901, Paris-Bordeaux (Gordon-Bennett Cup), and Paris-Berlin. The other French races, referred to in the remarks in the Appendix (p. 402) on 'Races and Trials,' have been arranged by other clubs or various journals. The Automobile Club de France has also held

a number of competitions as under: 1897, Concours de Poids Lourds, or 'Heavy Weights,' answering to the motor-waggon trials held at Liverpool; 1898, Concours de Poids Lourds, Concours de Fiacres; 1899, Concours de Poids Lourds, Concours de Fiacres, and Concours d'Accumulateurs; 1900, Concours de Voitures de Tourisme, Concours de Motocycles, Concours de Fiacres, Concours de Voiturettes, Concours de Véhicules de Petite Livraison (light delivery vans), and Concours de Poids Lourds. The last six were held in connection with the Exposition Universelle of that year. During the continuation of these trials the competing vehicles are housed nightly in a building under the surveillance of the Club, and the technical committee carefully notes the weights of water, fuel, grease, &c., or the quantity of electrical energy required by each. An official observer also accompanies each vehicle whilst on the journey, notes all the stoppages, repairs, and speeds arrived at on various sections of the road, and full reports are prepared and printed after the completion of the trials. It should also be added that the Club has taken a leading part in the promotion of annual automobile shows in Paris, at which the latest products of the French manufacturers have been displayed, and which have attracted visitors from all parts of Europe.

NORMANDY.—The Automobile Club Normand has its headquarters at 4 *bis* Boulevard d'Orléans, Rouen, near the Gare d'Orléans and the Place Carnot. It was founded in January 1900, with M. Ballif, of the Touring Club de France, as *Président d'Honneur*. The chief officers are as follows:—President, M. Bridoux; vice-president, M. Mouy; treasurer, M. Naltet; secretary, M. Bonnemain. The club premises include a *garage*, open day and night, and members of the Automobile Club of Great Britain and Ireland may house their cars at the following reduced tariff on presentation of their cards:—For a car weighing over 400 kilogrammes (8 cwt.), 1 day, 1 fr. 80 c.; 1 month, 9 frs. For a voiturette, 1 day, 1 fr.

35 c., 1 month, 6 frs. 30 c. Cleaning, 3 frs. 15 c. for a car, and 2 frs. 25 c. for a voiturette.

BORDEAUX.—The Automobile Club Bordelais was founded in May 1897, and its headquarters are at 2 Place de la Comédie, Bordeaux. Its chief officers are as follows:—President, M. D. Creuzan; vice-president, M. Lanneluc; treasurer, M. Igusquiza; secretary-general, M. L. Lestonnat; secretary, M. Puisarnand; librarian, Mr. J. S. Walton. There are about 250 members. The club conducts races for automobiles and balloons, and fortnightly tours. The annual subscription is 50 frs., with a like amount as entrance fee.

NICE.—Of provincial clubs the Automobile Club de Nice is undoubtedly the most active and important. It was founded in 1897 as the Auto-Vélo Club, but changed its name in 1900. From its foundation the Club has annually held races, competitions, and tours of an international character, with a view to popularising the new means of locomotion and improving the vehicles themselves. The Club was also the originator of the battles of flowers, *concours d'élégance*, &c., which have been widely imitated. Most of the races are held in the spring, and the 'Nice Week' has become one of the classic events of the automobile year. The president of the Club is M. Jacques Goudoin; the vice-presidents are MM. Ernest Sardou and Paul Chauchard; the treasurer is M. Ferdinand Crossa, and the secretary, M. Pierre Clérissy. At 5 Boulevard Gambetta the Club has a villa standing in its own garden, a pavilion restaurant, and a spacious *garage*, the background of which is formed by a panorama of the Bois de Boulogne. There are 308 members of the club, the subscription to which is 50 frs., and the entrance fee 20 frs. A weekly gazette, the 'Automobile Revue du Littoral,' is issued under the direction of the Club.

DORDOGNE.—The Dordogne Automobile Club, the full title of which is Le Véloce Club Périgourdin et Automobile

Club de la Dordogne, has its headquarters at the Grand Hôtel du Commerce et des Postes, 8 Place du Quatre-Septembre, Périgueux. Its officers are :—President, Le Comte F. de Fayolle ; treasurer, M. Louis Didon ; secretary, M. H. Soymier. There are fifty-eight members. Members of the A.C.G.B.I. touring in this district may store their cars at the V.C.P.A.C.D. garage without charge, and will be afforded every assistance by the officials.

BELGIUM.—The Automobile Club de Belgique was founded on May 7, 1896, and its headquarters are at 5 Place Royale, Brussels. The King of the Belgians is its 'Haut Protecteur,' and Prince Albert of Belgium its honorary president. The officers for 1902 are as follows :—President, Comte de Henri-court de Grünne ; vice-presidents, MM. de Savoye and de Limburg-Stirum ; treasurer, M. d'Aubreby ; secretary, Comte de Villegas de Saint-Pierre. In various ways the Belgian club has been active during the past two years. It holds an annual race meeting at Spa, and also a 'Fête du Cinquenaire,' while in 1901 a combined 'Tour de Belgique' was successfully undertaken. The Club also devotes its efforts to the improvement of the Belgian highways, the securing of a uniform code of police regulations concerning automobiles, and the removal of foreign customs restrictions. In March, 1902, the Club organised an automobile exhibition in Brussels.

THE NETHERLANDS.—The Nederlandsche Automobile Club was founded in 1898. As yet it has no quarters, but correspondence may be addressed to Herr Joannes D. Waller, the secretary, at Driebergen, near Utrecht. The other officers are :—President, Le Chevalier de Nahuys ; treasurer, J. P. Backx. The annual subscription is 25 guilders (2*l.* 1*s.* 8*d.*) and the entrance fee ten guilders (16*s.* 8*d.*). There are 135 members. The Club has over eighty hotels under contract, and a similar number of benzine dépôts, of which it publishes lists.

SWITZERLAND.—The Automobile Club de Suisse has headquarters at 2 Rue de Hesse, Geneva, and was founded in December 1898, and has 424 members. The officers are :—President, M. Aloys Naville ; vice-presidents, MM. Ernest Cuénod, A. Téron, and L. Empeyta ; secretary-general, M. Hermann Potry ; technical secretary, M. Paul Buchet ; treasurer, M. François Panchaud. The annual subscription is 20 frs. The Swiss club is a very active body, and is doing its utmost to increase custom-house facilities and to render homologous the various regulations in force in the different cantons concerning automobile traffic. It is also extending the provision of *garages* and the sale of petrol among the hotels of the country generally.

GERMANY.—The Deutscher Automobil Club was founded on July 31, 1899, and has 297 members. Its headquarters are at Sommerstrasse 4A, Berlin. H.I.H. the Grand Duchess Anastasie von Mecklenburg-Schwerin is Patroness, and H.R.H. Duke Frederick Franz IV. von Mecklenburg-Schwerin and H.E. General von Podbielski, Secretary of State, are honorary members. The president is H.I.H. the Duke of Ratibor, and the vice-presidents are Major Count Clemens von Schönborn-Wiesentheid and General von Rabe. The secretary is Baron von Molitor. The annual subscription is 100 marks and the entrance fee 100 marks. Lady members pay half these amounts.

AUSTRIA.—The Oesterreichischer Automobil Club was founded on February 6, 1898, and has nearly 500 members. Its headquarters are at Kärnthnerring 10, Vienna. The officers are :—Honorary president, Count Gustav Potting-Persing ; president, Count Carl Schönborn-Buckheim ; vice-president, Herr Georg Goebel ; secretary, Herr Josef Fellner, Kirchberggasse 7, Vienna. The subscription is 50 kronen, and the entrance fee is 60 kronen. Members of automobile Clubs with which reciprocal arrangements are in force may use the club premises for a period

of four days on presentation of a special card. The A.C.G.B.I. is one of the Clubs in question. The Austrian Club has an active membership, and promoted the Paris-Vienna race of 1902.

ITALY.—The Veloce Club e Club Automobilisti d'Italia was founded in 1897. Its headquarters are at Milan. The officers are:—President, Cav. F. Johnson; vice-president, Signor O. Odorico; secretary, Cav. F. Pizzagalli. There are 974 members, of whom 258 are ladies. The subscription is 40 *lire*, and the entrance fee 10 *lire*.

AMERICA.—The Automobile Club of America was founded on June 7, 1899. Its rooms are located in the Plaza Bank Building, 753 Fifth Avenue, New York, at the entrance to Central Park. There are 301 active and 63 associate members. The subscription for active members is 50 dollars per annum, with 100 dollars entrance fee; for associate members the subscription is 25 dollars and the entrance fee 50 dollars. The officers are as follows:—President Albert R. Shattuck; vice-presidents, Genl. Geo. Moore Smith, Edwin Gould, and Harry Payne Whitney; treasurer, Jefferson Seligman; secretary, S. M. Butler. The American Club has chiefly devoted its efforts to obtaining reasonable legislation in reference to the use of the highway by motor vehicles; the carriage of gasoline motor vehicles on ferries; and the furthering of the good roads movement throughout the country by the circulation of literature and by the arduous work of a 'good roads committee' of the Club. The encouragement by the Club of the manufacture of motor-cars has taken the form of two successful automobile exhibitions held in Madison Square Garden in November of 1900 and 1901 respectively; while in September, 1901, a 500-miles Endurance Contest was organised from New York to Buffalo over exceedingly rough and bad roads. There were eighty starters, of which forty-two finished at Rochester, some forty miles from Buffalo, where the contest was abandoned

owing to the assassination of President McKinley. In racing matters the Club has formulated a set of racing rules under which licences for race meetings have been granted to some ten or twelve clubs throughout the country. The Club has also assisted in the formation of nearly all of the thirty odd clubs which now exist in the United States, and has established reciprocal relations with the leading automobile clubs of Europe. Fortnightly Club runs are held during the spring and autumn, and in winter fortnightly suppers and lectures are given at the headquarters. A library has been established at the latter, containing all the automobile literature and periodicals of the world. The privileges of the Club are open to members of the Automobile Club of Great Britain and Ireland for a period of ten days, on production of an official card of introduction.

APPENDIX

AUTOMOBILE LITERATURE

BY C. L. FREESTON

IF the literature of automobilism is not at present overwhelming in its periodic forms, it is fast approaching the prolific stage. The number of weekly and monthly papers in the United Kingdom, France, and the United States, produced directly in the interests of the automobile industry or pastime, is already considerable, and a further increase is foreshadowed by the rapid strides which horseless locomotion is making all over the civilised world. In the way of permanent literature, however, the movement can by no means be described as suffering from plethora, a fact which is easily attributable to the constantly recurrent changes in the mechanical evolution of the motor-car.

The most interesting fact connected with the periodical literature of the movement is the prescience of the founders of 'The Autocar,' a journal which made its appearance, if not in advance of automobilism itself, at all events in advance of the passing of the emancipating Act of 1896. The first number of 'The Autocar' was published on November 2, 1895, or more than a year before the Locomotives on Highways Act of 1896 came into operation. The bulkiness of its present form is a testimony alike to its own prosperity and to the growth of the automobile industry. It is well printed and illustrated, and is published every Friday at threepence by Iliffe & Sons, Ltd., 3 St. Bride Street, London, and Coventry.

The 'Automotor and Horseless Vehicle Journal' was also early in the field, its first number having been issued in October 1896.

Like 'The Autocar,' it coined a new word for purposes of self-description. For five and a half years it was published on the 15th of each month at sixpence, and was distinguished by the high technical value of its articles, as well as by its independence of tone. At the time of going to press with this volume, however, 'The Automotor Journal' is announced to appear in weekly form, the price being reduced to twopence. The publishers are F. King & Co., Limited, 62 St. Martin's Lane, W.C.

In less technical guise than either of the foregoing 'The Motor-Car Journal,' which made its first appearance on March 10, 1899, has served a useful purpose in popularising the movement. It is a bright and attractive pennyworth, and a handy chronicle of current events in the automobile world. The publishers are C. Cordingley & Co., 39 and 40 Shoe Lane, E.C.

'Motor Cycling' is the name of a new weekly, specially devoted to that particular phase of automobilism. The first number appeared on February 12th, 1902, and was found at once to be a useful compendium for those interested in the subject. It is published at a penny by the Temple Press, Ltd., 7 Rosebery Avenue, E.C.

The latest arrival on the scene is 'Motoring Illustrated,' which dates from March 1902. Its aims appear to be high as regards the quality of its articles and illustrations. The price is threepence, and it is published at 9 Arundel Street, Strand, W.C.

Of monthly organs published in the United Kingdom there are now two. 'The Motor-Car World,' price threepence, is issued by Hay, Nisbet, & Co., of 19 Queen Street, Glasgow. 'The Motor News,' which came out in the first instance as 'The Irish Motor News,' is published at threepence by R. J. Mecedry & Co., Dame Court, Dublin, and has always been distinguished for the practical value of its articles from the private owner's point of view.

Reference should also be made to the 'Notes and Notices' of the Automobile Club of Great Britain and Ireland, issued at irregular intervals to members only. Originally this was a mere circular of official announcements, but it has since assumed quite formidable proportions. To the private user of a car it is almost indispensable, and non-members of the Club or of the Motor Union of necessity miss a considerable amount of useful information.

In the United States the automobile movement has sufficiently

progressed to warrant the appearance of several weekly and monthly organs. Naturally, however, they contain a great deal more about steam and electric vehicles than the petrol-driven types. The most important weekly is the 'Horseless Age,' published at 147 Nassau Street, New York, at the price of 10 cents. It is illustrated, but the blocks are mostly diagrammatic. Of very similar type is the 'Motor World' (price 10 cents), issued every week at 123-5 Tribune Buildings, 154 Nassau Street, New York. Another weekly, of a more popular type, is 'Automobile Topics' (10 cents), published at Park Row Building, New York.

Of American monthly organs the best is the 'Automobile Magazine' (25 cents), published at 170 Broadway, New York. It is well printed and illustrated. Other serials are the 'Automobile' (10 cents), 150 Nassau Street, New York, and the 'Motor Review' (5 cents), 395 Broadway, New York. The last-named makes a speciality of European correspondence.

But it is to the French press that the English automobilist may most profitably turn for current information such as may not be included in home publications. France supports not only several weekly automobile organs, but two dailies almost entirely devoted to automobilism and cycling, and of a totally different character from the 'sporting daily' as understood in Great Britain.

'Le Vélo' has been in existence for several years, and when the editorship came to be undertaken by M. Pierre Giffard, a prominent feuilletonist, it entered on a course of extraordinary popularity. Unfortunately, it espoused the cause of a clique set in motion against the Automobile Club de France, and that body immediately established the 'Auto-Vélo' as a daily of similar type. 'Le Vélo' is still published, however, at 2 Rue Meyerbeer, Paris. The price is 5 centimes.

'L'Auto-Vélo' (5 centimes) has been a success from the first. English automobilists who take an interest in Continental racing turn to its columns daily for the latest information, whilst it also contains the official *communiqués* of the French Automobile Club. The 'Auto-Vélo' organises annually numerous races and trials, and is conducted generally with great spirit. The offices are at 10 Rue du Faubourg-Montmartre, Paris.

'La France Automobile' is the most useful of the French automobile weeklies to the English reader, as it contains good illustrations of the various races and other competitions, and of new cars

or other novelties. Its price is 50 centimes, and it is published at 68 Avenue de la Grande Armée, Paris.

'La Locomotion Automobile' (50 centimes) is also a practically written weekly, published at 4 Rue Chauveau Lagarde, Paris.

Among other Continental organs devoted wholly or to an appreciable extent to automobilism in its various aspects are the following :—

'Le Chauffeur.' Bi-monthly ; 'The oldest technical journal in France' ; 26 Place Dauphine, Paris.

'L'Industrie Vélocipédique et Automobile.' Monthly ; 50 c. ; 75 Rue Vieille du Temple, Paris.

'Automobile Revue du Littoral.' Fortnightly ; 15 c. ; 26 Avenue de la Gare, Nice.

'L'Avenir de l'Automobile et du Cycle.' Monthly ; 15 f. per annum ; 22 Rue Rossini, Paris.

'L'Automobile Belge.' Weekly ; 10 c. ; 70 Rue Dethy, St. Gilles, Brussels. The official organ of the Belgian Automobile Club.

'L'Automobile Illustré.' Fortnightly ; 15 f. per annum ; 163 Rue des Palais, Brussels.

'La Suisse Sportive.' Fortnightly ; 20 c. ; 6 Rue de Commerce, Geneva.

'Zeitschrift Automobilen-Industrie und Motorenbau.' Fortnightly ; 40 pfennig ; 86 Steglitzerstrasse, Berlin.

'Allgemeine Automobil Zeitung.' Weekly ; 50 heller ; 3 Steyrerhof, Vienna.

'L'Automobile.' Bi-monthly ; 2 Via Corte d' Appello, Turin.

As regards automobile works of reference, those which appeared about the time of the passing of the Act of 1896 are now of no practical value, while several years elapsed before any attempt was made, in Great Britain at least, to replace them.

The most important book is 'Motor Vehicles and Motors,' by W. Worby Beaumont, published in 1900 by Archibald Constable & Co., London. The price is two guineas. It is a portly volume of 636 quarto pages, with about 250 illustrations, many of which are of an elaborate nature. The technical value of this work, more especially to the designer, is very great, and the volume is a monument alike to the importance of the industry and to the ability and industry of its author.

Of other works which possess any current value the following may be named :—

'Light Motor-Cars and Voiturettes,' by John Henry Knight, London, Iliffe & Sons, Ltd., 1902 ; 2s. 6d.

'Motor-Cycles and How to Manage Them,' by A. J. Wilson; London, Iliffe & Sons, Ltd., 1901; 2s. 6d.

'The Automotor Pocket-Book,' 1902; London, F. King & Co., Ltd.; 1s.

'The Automotor Directory,' 1902; London, F. King & Co.; 3s. 6d.

'The Automobilists' Guide,' by R. E. Phillips, 1902; London, F. King & Co.; 3s. 6d.

'The Motor-Car Manual,' by R. Moffat Ford, 1901; London, The Motor-Car Co.; 2s. 6d.

'The De Dion Voiturette,' by R. J. Mecredy, 1901; Dublin, Mecredy & Co.; 6d.

'The Daimler Car,' by R. J. Mecredy, 1901; Dublin, Mecredy & Co.; 6d.

'L'Automobile (Théorique et Pratique),' by Baudry de Saunier; Paris, 1899.

'Annuaire General de l'Automobile, et des Industries qui s'y rattachent,' 1902; Paris, Thévin & Houry.

The following is a list of publications issued by the Automobile Club, which may be obtained of Messrs. King & Co., 62 St. Martin's Lane :—

'Judges' Report, Richmond Show,' 1899; 1s. 2d., post free.

'Programme and Report of the 1,000 Miles Trial, 1900; 1s., post free.

'Official 100 Miles Trials of the Automobile Club,' reprinted from 'Notes and Notices'; 4d., post free

'Programme of Glasgow Reliability Trials and Judges' Report and Awards'; 6d., post free.

'Judges' Report of the Liverpool Trials of Motor Vehicles for Heavy Traffic'; 10s., post free.

RACES AND TRIALS

BY C. L. FREESTON

ONLY under the stress of competition are the weak points of a motor-car most strikingly revealed, and, per contra, its strong ones emphasised. Whatever opinions may be held as to the propriety of continuing the Continental races now that cars are capable of tremendous speeds, there is no gainsaying the fact that, without the influence which the early competitions in France exerted upon the public mind, and the lessons learned by makers themselves from the success or non-success of particular vehicles, the industry in France would not have arrived at the position it now holds ; nor, for that matter, would the English or German cars have attained their present degree of mechanical excellence.

Even with the aid of racing, however, the development of the motor-car has been a matter of slow growth, and by many new recruits to the pastime it may be learned with surprise that a competition was held in France so long ago as 1894, from Paris to Rouen, when the cars of Panhard et Levassor and Peugeot Frères shared the leading honours, with motors of $3\frac{1}{2}$ h.-p. The times are not recorded. It was not until June 1895, however, that the foundation of a series of classic events was laid by a race from Paris to Bordeaux and back, 732 miles, when a $3\frac{1}{2}$ -h.-p. Panhard et Levassor car accomplished the journey in 48 h. 48 m. at the rate of nearly fifteen miles per hour. The good effects of racing have been abundantly displayed since that memorable event, for even M. Panhard himself was satisfied with the results, and progress might have been stayed for an indefinite period but for the stimulus of competition. The story is vouched for that at a banquet following this event an enthusiastic, yet prescient, speaker expressed the belief that the journey to Bordeaux would eventually be covered not at fifteen, but at fifty, miles an hour. Thereupon M. Panhard leaned over to the chairman, the Baron de

Zuylen, and whispered a regret that on such occasions there was 'always one person who made an ass of himself.' Only six years later the course was covered at an even higher rate than was predicted by the after-dinner prophet, and, among others, by Panhard cars, though the founder of the firm unfortunately did not live to witness this startling consummation.

In September 1896, a race was held from Paris to Marseilles and back (1,061 miles), and two 4-h.-p. Panhard cars completed the course at the average speed of 15·65 and 15·55 miles an hour respectively, with four passengers, as against the two of the Bordeaux race. More definite progress, moreover, was soon to be recorded, for on July 24, 1897, a race was run from Paris to Dieppe (106 miles), and was won by a 6-h.-p. Panhard in 4 h. 36 m., or 23·1 miles an hour. On July 7, 1898, an 8-h.-p. Panhard averaged 29 miles an hour in a race of 895 miles from Paris to Amsterdam and back, and by the next year the 12-h.-p. car had appeared upon the scene, the Paris-Bordeaux race being won by a Panhard of that power in 11 h. 43 m. 29 s., or 33·30 miles an hour.

The year 1899 also witnessed the great 'Tour de France,' a race of no less a distance than 1,440 miles, which was won by a 16-h.-p. Panhard, driven by de Knyff in 44 h. 59 m., or 31·9 miles an hour. The interesting fact may here be stated that in every race yet mentioned the first three cars were all Panhards, and the fourth was invariably a Peugeot, up to the 'Tour de France,' when a Bollée stepped into the place. The Mors vehicle, however, now proved a formidable rival to the Panhard. In the Paris-St. Malo race two 16-h.-p. cars of that make came in first and second, driven by Antony and Levegh, in 7 h. 32 m. and 7 h. 40 m. respectively, over a distance of 226 miles. In the Paris-Ostend race (201 miles) Levegh on a 16-h.-p. Mors, and Girardot on a 12-h.-p. Panhard, made a dead heat of it, their time being 6 h. 11 m., or 32½ miles an hour. Girardot, however, won the Paris-Boulogne race (143 miles) in 4 h. 17 m. 44 s.; Levegh's time was 4 h. 19 m. 20 s., the winner's speed being 33½ miles an hour. A subsequent race from Bordeaux to Bayonne (163 miles) was won by Levegh in 4 h. 24 m.

In 1900 the 'Circuit du Sud-Ouest' race, from Pau over a course of 208 miles, was won by de Knyff, who made the astonishing time of 4 h. 46 m. 57 s., averaging 43½ miles an hour, and being credited on one stage with 34 miles in 33½ minutes. He drove a 16-h.-p.

Panhard. No other competitor came anywhere near de Knyff's time ; the Comte Bozon de Périgord was second in 5 h. 33 m. 52½ s.

The Nice to Marseilles race was won by de Knyff on a Panhard, at an average rate of 36·6 miles per hour for the 125 miles, two other Panhards being close up. Levegh, however, on a Mors, won the La Turbie hill-climbing race (10½ miles) at 33·1 miles per hour, the mile race at 36½ miles per hour, and the flying kilometre at 46½ miles per hour.

Levegh did another remarkable performance in the Bordeaux-Périgueux-Bordeaux race (195½ miles), covering the distance in 4 h. 1 m. 45 s. The first stage of this race (72 miles) was accomplished in 1 h. 24 m. 35 s., equal to 51 miles an hour.

The first race for the Gordon-Bennett or International Cup was run from Paris to Lyons (353½ miles), and France had it all her own way. Charron won in 9 h. 9 m. on a Panhard, his speed averaging 38·45 miles an hour. Girardot was the only other competitor to finish, de Knyff breaking his fourth speed. Winton (America) and Jenatzy (Belgium) abandoned the race.

An exceedingly unfortunate race was that from Paris to Toulouse and back ; it was run in three stages during a heat wave, and tyre troubles were numerous. Levegh on his Mors covered the distance of 838·08 miles, excluding controls, in 20 h. 50 m. 9 s., an average of 40 miles an hour. Pinson was second in 22 h. 11 m. 1 s., and Voigt third in 22 h. 11 m. 51 s., each driving a Panhard.

The Pau meeting of 1901 produced a good performance by Maurice Farman, who won the Grand Prix de Pau race (205 miles) in 4 h. 28 m. 20 s. on a 24-h.-p. Panhard, thus averaging 46 miles per hour.

At Nice the Nice-Salon-Nice race (244 miles without controls) was won by Baron Henri de Rothschild (35-h.-p. Mercédès) in 6 h. 45 m. 48 s. In the Coupe de Rothschild flying kilometre, a Serpollet car made the remarkable time of 35½ seconds, or 62½ miles per hour. Four Mercédès cars came next in order, the best time being 41½ seconds. In the La Turbie hill-climb the fastest car was Baron de Rothschild's Mercédès, its time being 18 m. 6½ s., or 31½ miles per hour. The Serpollet's time was 24 m. 11½ s.

The Gordon-Bennett and Paris-Bordeaux races were run on the same day, and over the same course, in 1901. In the first-named Girardot won on a 40-h.-p. Panhard in 8 h. 50 m. 59 s., or 37 miles per hour. No one else finished. A much more interesting affair was the Paris-Bordeaux race, which was won by Fournier on a

Mors of 60 b.h.-p., in the splendid time of 6 h. 10 m. 44 s., an average of 53 miles an hour. Maurice Farman, on a Panhard, was second in 6 h. 41 m. 15 s. ; and Voigt third in 7 h. 15 m. 11 s.

A still greater event was the Paris-Berlin race, which attracted the attention of the entire Continent. Fournier repeated his previous success, winning in the net time of 16 h. 5 m., Girardot being second in 17 h. 7 m., de Knyff third in 17 h. 11 m., and Brasier fourth in 17 h. 42 m. The distance, excluding controls, was 749 miles, Fournier thus averaging $46\frac{1}{2}$ miles an hour over the three days' course.

Of a very different character from these magnificent displays of physical endurance and mechanical speed, but interesting, nevertheless, from many points of view, have been the various trials conducted by the Automobile Club of Great Britain and Ireland. Of necessity they have been tests of efficiency, pure and simple ; the Club has never held a road-race of any description, and its only speed tests on the flat have been on a private road in Welbeck Park. Sundry hill-climbing competitions have been held on the public highway, but in cases where a powerful car has been able to exceed the legal limit of speed, such excess has not been officially recorded. The Club has also held petroleum spirit trials, brake trials, and non-stop runs of 100 miles, in addition to the Thousand Miles Trial of 1900 and the 'Glasgow Week' in 1901.

The first important trials of the Club were in connection with the Richmond Show in 1899, when a number of cars competed in the ascent of Petersham Hill, the maximum gradient of which is 1 in 9.43. Few of the cars of that date could do much better than five miles an hour, but the 8-h.-p. Panhard driven by the Hon. C. S. Rolls ascended at $8\frac{3}{4}$ miles per hour. It also made a non-stop run of fifty miles on the Oxford Road. Other non-stop journeys were made by a $5\frac{1}{2}$ -h.-p. Daimler, two Benz cars, a Lanchester phaeton, a Delahaye, a Motor Manufacturing, and a Hercules car respectively.

The great Thousand Miles Trial of 1900 extended from April 23 to May 12. No fewer than sixty-five vehicles started, the majority of which completed the course. The following maintained a speed of not less than the legal limit throughout :—Section I. (Manufacturers) :—Gladiator, de Dion and Wolseley voiturettes, Motor Manufacturing Iveagh, 6-h.-p. Daimler, Ariel quadricycle, and Ariel tricycle with trailer. Section II. (Private Owners) :—

6-h.-p. Panhard (Mr. T. B. Browne), 8-h.-p. Napier (Mr. E. Kennard), 12-h.-p. Daimler (Hon. J. Scott-Montagu, M.P.), 12-h.-p. Panhard (Hon. C. S. Rolls), and 12-h.-p. Daimler (Mr. J. A. Holder).

In a speed trial at Welbeck Park the following were the best times for the mean of two tests over a mile course :—Mr. Rolls's 12-h.-p. Panhard, 37·63 miles per hour ; Mr. Kennard's 8-h.-p. Napier, 29·6 ; Mr. Mark Mayhew's 8-h.-p. Panhard, 29·6 ; Ariel tricycle with trailer, 29·45 ; Mr. Holder's Daimler, 26·23.

Four hill-climbing competitions were held during the trial. At Teddington the following ascended at 12 miles per hour or over : Ariel tricycle (Mr. A. J. Wilson), 12-h.p. Panhard (Hon. C. S. Rolls), Ariel quadricycle, Ariel tricycle with trailer, 8-h.-p. Napier (Mr. E. Kennard), and 12-h.-p. Daimler (Mr. J. A. Holder). At the steep portion of Shap Fell the Empress tricycle and Mr. Rolls's Panhard were the most successful. On Dunmail Raise the Napier, Empress tricycle, and Mr. Rolls's Panhard were 'up to the limit,' while on Birkhill the Ariel quadricycle, Ariel tricycle with trailer, Enfield quadricycle, and Mr. Rolls's Panhard achieved the same result. Numerous prizes were awarded at the conclusion of the trials, the gold medal for the best car in any class being bestowed on Mr. Rolls's Panhard.

Less ambitious in respect of distance, but more practical in other ways, were the Glasgow Trials of September 2 to 6, 1901. Every car had an official observer throughout, so that each stoppage was recorded, save those for punctures. The following cars gained the daily maximum possible of 300 marks :—Class A (250*l.* or under), Argyll voiturette ; Class C (350*l.* to 500*l.*), 8-h.-p. Arrol-Johnston ; Class D (over 500*l.*), 9-h.-p. Napier. A considerable number of other cars came very near the maximum. In the compulsory hill-climbing trials at Fintry and Gleneagles the highest awards of marks were as follows :—Section I., Class A, 7-h.-p. New Orleans, 341 marks ; Class B (250*l.* to 350*l.*), 6-h.-p. M.M.C., 183 marks ; Class C, M.C.C. 6-seated car, 321 marks ; Class D, 16-h.-p. Milnes, 159 marks. Section II., Mr. William Exe's 7-h.-p. New Orleans, 349 marks. The highest totals in respect of trustworthiness and hill-climbing were as follows :—Section I., Class A, 7-h.-p. New Orleans, 1,807 marks ; Class B, 6-h.-p. M.M.C., 1,675 ; Class C, M.M.C. car, 1,814 ; Class D, 16-h.-p. Milnes, 1,657. Section II., Mr. William Exe's New Orleans, 1,836.

Other points as to which no marks were published, were taken into consideration by the judges, and the gold medals were

awarded to two Wolseley cars, a Locomobile, a 16 h.-p. Milnes, and a 6-h.-p. M.M.C. delivery van.

A petroleum spirit trial was held on April 13, 1901, over a thirty-mile course from Sheen House, on a very unfavourable day for economical consumption. The best record was one of 7·9 pints by a 6-h.-p. New Orleans car, a 7-h.-p. New Orleans coming next with one gallon.

Another consumption trial took place on May 2, 1901, at Dashwood Hill, combined with a hill-climbing trial and a non-stop run of 31 miles each way between London and the foot of the hill. The hill was ascended seven times by each car, these representing a distance of four miles in all and a rise of 1,470 feet. The most economical consumption record was that of a 7-h.-p. New Orleans with 1·03 gallon for the outward journey, '33 gallon on the hill, and '875 gallon in returning to town. As regards the ascent, the Hon. J. Scott-Montagu's 24-h.-p. car and Mr. J. R. Hargreaves's 19-h.-p. Daimler were up to the legal limit, while the 7-h.-p. New Orleans did 10·36 miles per hour. Non-stop runs were made on both journeys by the 8½-h.-p. Decanville, 7-h.-p. New Orleans, 6-h.-p. Daimler, 5-h.-p. Wolseley, and 3-h.-p. Ariel quadricycle.

Another hill-climbing trial, open to all comers, was held at Dashwood Hill on July 6, 1901. Each vehicle was required to ascend three times, with a full load of passengers weighing not less than 10½ stones each. The following cars ascended 'up to the legal limit':—50-h.-p. Napier, 16-h.-p. Daimler, and 12-h.-p. Chainless in the petrol-driven class, and the Locomobile and Weston steam-cars also. On the premise, however, that the best vehicle is the one which at the lowest purchase price can convey the greatest number of passengers at the highest speed, the Trials Committee awarded the Chainless the highest marks, a 7-h.-p. Panhard coming second, and a 4½-h.-p. Renault third, the times of the latter two being 10 and 6·3 miles per hour respectively. In the steam class the Locomobile was placed first.

* Several challenge cups having been offered for motor-cyclists, the Automobile Club has superintended the meetings at which the trophies were competed for. The 'Autocar' cup was won by Machin in 1900 on a 7-h.-p. Aster tricycle, his record being 39 miles 324 yards in the hour. In 1901 the cup was gained by C. Jarrott, on an 8-h.-p. De Dion tricycle, the distance covered being 36 miles 797 yards. The 'Motor Car Journal' cup for touring cycles, handicapped for a five-miles course, was won in 1900 by

A. E. J. Steele on a Simpson and Strickland tricycle in 11 m. 2½ s. The winner in 1901 was C. Jarrott, on a 2½-h.-p. De Dion tricycle, his time being 10 m. 10½ s. A ten-miles handicap for the 'Automotor' cup was secured in 1900 by E. Buck, who won in 14 m. 2½ s. Jarrott was the winner in 1901, his time being 14 m. 47½ s. on the 8-h.p. de Dion. A one-mile handicap for motor bicycles, for a cup offered by Mr. Campbell Muir, was won in 1901 by J. Leonard on a 1½-h.-p. Werner, in 1 m. 53½ s.

In the quarterly 100 miles competitions initiated in November 1899, the following cars have made the journey without a stop :— 3-h.-p. Benz, 5½-h.-p. Daimler, 16-h.-p. Milnes, and 6-h.-p. Simms. A 2½-h.-p. Beeston tricycle also made a non-stop run. Trials on which but insignificant stops were recorded were also made by the Motor Manufacturing Iveagh phaeton, 8-h.-p. Napier-Panhard, 6-h.-p. Peugeot, 6-h.-p. Darracq, 5-h.-p. Sirène, 4½-h.-p. De Dion, 6-h.-p. Gladiator, and 14-h.-p. Gobron-Brillié.

Lastly, mention must not be omitted of the interesting brake trials at Welbeck Park in January 1902, with the object of providing trustworthy data for the instruction of the Local Government Board, whose chief engineering inspector was present. After systematic experiments, officially timed and measured, the following were found to be the distances within which cars could be brought to a standstill :—

- From 11 to 14 miles per hour in 1½ time the car's length ;
- From 15 to 17 miles per hour in twice the car's length ;
- From 18 to 20 miles per hour in 2½ times the car's length ;
- From 20 to 24 miles per hour in 3½ times the car's length.

THE MOTOR LAWS AS THEY EXIST

THE LIGHT LOCOMOTIVES' ACT OF 1896

An Act to amend the Law with respect to the Use of Locomotives on Highways. [14th August 1896.]

BE it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same as follows:—

Exemption of Light Locomotives from Certain Statutory Provisions.—1. (1.) The enactments mentioned in the schedule to this Act, and any other enactment restricting the use of locomotives on highways and contained in any public general or local and personal Act in force at the passing of this Act, shall not apply to any vehicle propelled by mechanical power if it is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not to exceed in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause; and vehicles so exempted, whether locomotives or drawn by locomotives, are in this Act referred to as light locomotives.

Provided that—

- (a) the council of any county or county borough shall have power to make byelaws preventing or restricting the use of such locomotives upon any bridge within their area, where such council are satisfied that such use would be attended with damage to the bridge or danger to the public;
 - (b) a light locomotive shall be deemed to be a carriage within the meaning of any Act of Parliament, whether public general or local, and of any rule, regulation, or byelaw, made under any Act of Parliament, and, if used as a carriage of any particular class, shall be deemed to be a carriage of that class, and the law relating to carriages of that class shall apply accordingly.
- (2.) In calculating for the purposes of this Act the weight of a vehicle unladen, the weight of any water, fuel, or accumulators, used for the purpose of propulsion, shall not be included.

Regulation as to Lights.—2. During the period between one hour after sunset and one hour before sunrise, the person in charge of a light locomotive shall carry attached thereto a lamp so constructed and placed as to exhibit a light in accordance with the regulations to be made by the Local Government Board.

Locomotives to Carry a Bell.—3. Every light locomotive shall carry a bell or other instrument capable of giving audible and sufficient warning of the approach or position of the carriage.

Rate of Speed.—4. No light locomotive shall travel along a public highway at a greater speed than fourteen miles an hour, or than any less speed that may be prescribed by regulations of the Local Government Board.

Use of Petroleum, &c.—5. The keeping and use of petroleum or of any other inflammable liquid or fuel for the purpose of light locomotives shall be subject to regulations made by a Secretary of State, and regulations so made shall have effect notwithstanding anything in the Petroleum Acts, 1871 to 1881.

Local Government Board Regulations.—6.—(1.) The Local Government Board may make regulations with respect to the use of light locomotives on highways, and their construction, and the condition under which they may be used.

(2.) Regulations under this section may, if the Local Government Board deem it necessary, be of a local nature and limited in their application to a particular area, and may, on the application of any local authority, prohibit or restrict the use of locomotives for purposes of traction in crowded streets, or in other places where such use may be attended with danger to the public.

All regulations under this section shall have full effect notwithstanding anything in any other Act, whether general or local, or any byelaws or regulations made thereunder.

Every regulation purporting to be made in pursuance of this section shall be forthwith laid before both Houses of Parliament.

Penalties.—7. A breach of any byelaw or regulation made under this Act, or of any provision of this Act, may, on summary conviction, be punished by a fine not exceeding ten pounds.

Excise Duty on Certain Locomotives.—8.—(1.) On and after the first day of January next after the passing of this Act there shall be granted, charged, and paid in Great Britain for every light locomotive, which is liable to duty either as a carriage or as a hackney carriage under section four of the Customs and Inland Revenue Act, 1888, an additional duty of excise at the following rate; namely—

	£	s.	d.
If the weight of the locomotive exceeds one ton unladen,			
but does not exceed two tons unladen	2	2	0
If the weight of the locomotive exceeds two tons			
unladen	3	3	0

(2.) Every such duty shall be paid together with the duty on the licence or the locomotive as a carriage or a hackney carriage, and shall in England be dealt with in manner directed with respect to duties on local taxation licences within the meaning of the Local Government Act, 1888; and in Scotland be paid into the Local Taxation (Scotland) Account, and be dealt with as part of the residue within the meaning of section two, subsection (3), of the Local Taxation (Customs and Excise) Act, 1890.

Construction of Wheels of Locomotives on Roads.—9. The requirements of subsection (4) of section twenty-eight of the Highways and Locomotives Amendment Act, 1878, may be from time to time varied by order of the Local Government Board.

Application to Scotland.—10. In the application of this Act to Scotland a reference to the Secretary for Scotland shall be substituted for a reference to the Local Government Board, a reference to the road authority of any county or burgh for a reference to the council of a county or county borough, and a reference to sub-section (4) of section three of the Locomotives Amendment (Scotland) Act, 1878, for a reference to sub-section (4) of section twenty-eight of the Highways and Locomotives Amendment Act, 1878.

Application to Ireland.—11. In the application of this Act to Ireland a reference to the Local Government Board for Ireland shall be substituted for a reference to the Local Government Board, and a reference to the council of a county shall be construed in an urban sanitary district under the Public Health (Ireland) Act, 1878, as a reference to the urban sanitary authority, and elsewhere as a reference to the grand jury.

Short Title and Commencement.—12. This act may be cited as the Locomotives on Highways Act, 1896, and shall come into operation on the expiration of three months from the passing thereof.

SCHEDULE

Enactments which are not to apply to Light Locomotives

The Locomotives Act, 1861 (24 & 25 Vict. c. 70), except so much of section one as relates to tolls on locomotives, and sections seven and thirteen.

Section forty-one of the Thames Embankment Act, 1862 (25 & 26 Vict. c. 93).

The Locomotives Act, 1865 (28 & 29 Vict. c. 83).

The Locomotives Amendment (Scotland) Act, 1878 (41 & 42 Vict. c. 58).

Part II. of the Highways and Locomotives (Amendment) Act, 1878 (41 & 42 Vict. c. 77).

Section six of the Public Health (Ireland) Amendment Act, 1879 (42 & 43 Vict. c. 57).

THE EXISTING LOCAL GOVERNMENT BOARD REGULATIONS

STATUTORY RULES AND ORDERS, 1896 No. 952

LOCOMOTIVE, ENGLAND

The Light Locomotives on Highways Order, 1896. Dated November 9, 1896

5.520

To the County Councils of the several administrative Counties in England and Wales;

To the Councils of the several County Boroughs in England and Wales;

To the Sanitary Authorities of the several Sanitary Districts in the Administrative County of London;

To the Urban District Councils of the several Urban Districts in England and Wales;

To the Rural District Councils acting as the Highway Authorities in Rural Districts in England and Wales;

And to all others whom it may concern.

Whereas by section 6 of the Locomotives on Highways Act, 1896 (hereinafter called the Act), it is enacted that—

‘(1.) The Local Government Board may make regulations with respect to the use of Light Locomotives on highways, and their construction, and the conditions under which they may be used.

‘(2.) . . . All regulations under this section shall have full effect notwithstanding anything in any other Act, whether general or local, or any bye-laws or regulations made thereunder.’

And whereas by section 7 of the Act it is enacted that—

‘During the period between one hour before sunset and one hour before sunrise, the person in charge of a light locomotive shall carry attached thereto a lamp so constructed and placed as to exhibit a light in accordance with the regulations to be made by the Local Government Board.’

And whereas by section 2 of the Act it is enacted that—

‘A breach of any . . . regulations made under this Act, . . . may on summary conviction, be punished by a fine not exceeding ten pounds.’

Now, therefore, in pursuance of the powers given to us by the Act, and by any other statutes in that behalf, we, the Local Government Board, do by

this our Order make the following regulations with respect to the use of light locomotives on highways, and their construction, and the conditions under which they may be used, and direct that the same shall have effect on and after the fourteenth day of November, one thousand eight hundred and ninety-six :—

ARTICLE I.—In this Order—

Definition.—The expression 'carriage' includes a waggon, cart or other vehicle.

The expression 'horse' includes a mule or other beast of draught or burden and the expression 'cattle' includes sheep.

The expression 'light locomotive' means a vehicle propelled by mechanical power which is under three tons in weight unladen, and is not used for the purpose of drawing more than one vehicle (such vehicle with its locomotive not exceeding in weight unladen four tons), and is so constructed that no smoke or visible vapour is emitted therefrom except from any temporary or accidental cause.

In calculating for the purposes of this Order the weight of a vehicle unladen, the weight of any water, fuel, or accumulators used for the purpose of propulsion shall not be included.

ARTICLE II.—No person shall cause or permit a light locomotive to be used on any highway, or shall drive or have charge of a light locomotive, when so used, unless the conditions hereinafter shall be satisfied, namely,—

Reverse.—1. The light locomotive, if it exceeds in weight unladen five hundredweight shall be capable of being so worked that it may travel either forwards or backwards.

Width.—2. The light locomotive shall not exceed six and a half feet in width, such width to be measured between its extreme projecting joints.

Tyres.—3. The tyres of each wheel of the light locomotive shall be smooth, and shall, where the same touches the ground, be flat and of the width following, namely,—

(a) if the weight of the light locomotive unladen exceeds fifteen hundredweight, but does not exceed one ton, not less than two and a half inches ;

(b) if such weight exceeds one ton, but does not exceed two tons, not less than three inches ;

(c) if such weight exceed two tons, not less than four inches.

Provided that where a pneumatic tyre or other tyre of a soft and elastic material is used, the tyre may be round or curved, and there may be upon the same projections or bosses rising above the surface of the tyre if such projections or bosses are of the same material as that of the tyre itself, or of some other soft and elastic material. The width of the tyre shall, for the purpose of this proviso, mean the extreme width of the soft and elastic material on the rim of the wheel when not subject to pressure. See appendix, viz., Order of Local Government Board *re* wood blocks in wheels.

Brakes.—4. The light locomotive shall have two independent brakes in good working order, and of such efficiency that the application of either to such locomotive shall cause two of its wheels on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effect in stopping the light locomotives as if such wheels were so held.

Provided that in the case of a bicycle this regulation shall apply as if, instead of two wheels on the same axle, one wheel was therein referred to.

Control.—5. The light locomotive shall be so constructed as to admit of its being at all times under such control as not to cause undue interference with passenger or other traffic on any highway.

Address and Weight to be Painted on Goods Vehicles.—6. In the case of a light locomotive drawing or constructed to draw another vehicle or constructed or used for the carriage of goods, the name of the owner and the place of his

abode or business, and in every such case and in the case of every light locomotive weighing unladen one ton and a half or upwards, the weight of the light locomotive unladen shall be painted in one or more straight lines upon some conspicuous part of the right or off side of the light locomotive in large legible letters in white upon black or black upon white, not less than one inch in height.

Not to be in a Dangerous Condition.—7. The light locomotive and all the fittings thereof shall be in such a condition as not to cause, or to be likely to cause, danger to any person on the light locomotive or on any highway.

Competent Person in Charge.—8. There shall be in charge of the light locomotive when used on any highway a person competent to control and direct its use and movement.

Lamps.—9. The lamp to be carried attached to the light locomotive in pursuance of Section 2 of the Act shall be so constructed and placed as to exhibit, during the period between one hour after sunset and one hour before sunrise, a white light visible within a reasonable distance in the direction towards which the light locomotive is proceeding or is intended to proceed, and to exhibit a red light so visible in the reverse direction. The lamp shall be placed on the extreme right or off side of the light locomotive in such a position as to be free from all obstruction to the light.

Provided that this regulation shall not extend to any bicycle, tricycle, or other machine to which Section 85 of the Local Government Act, 1888, applies.

ARTICLE III.—No person shall cause or permit a light locomotive to be used on any highway for the purpose of drawing any vehicle, or shall drive or have charge of a light locomotive when used for such purpose unless the conditions hereinafter set forth shall be satisfied, namely,—

1. Regulations 2, 3, 5, and 7 of Article II. of this Order shall apply as if the vehicle drawn by the light locomotive was therein referred to instead of the light locomotive itself, and Regulation 6 of the Article shall apply as if such vehicle was a light locomotive constructed for the carriage of goods.

Brakes on Trailers.—2. The vehicle drawn by the light locomotive, except where the light locomotive travels at a rate not exceeding four miles an hour, shall have a brake, in good working order, of such efficiency that its application to the vehicle shall cause two of the wheels of the vehicle on the same axle to be so held that the wheels shall be effectually prevented from revolving, or shall have the same effect in stopping the vehicle as if such wheels were so held.

Application of Brakes on Trailers.—3. The vehicle drawn by the light locomotive shall, when under the last preceding regulation a brake is required to be attached thereto, carry upon the vehicle a person competent to apply efficiently the brake: Provided that it shall not be necessary to comply with this regulation if the brakes upon the light locomotive by which the vehicle is drawn are so constructed and arranged that neither of such brakes can be used without bringing into action simultaneously the brake attached to the vehicle drawn, or if the brake of the vehicle drawn can be applied from the light locomotive independently of the brakes of the latter.

ARTICLE IV.—Every person driving or in charge of a light locomotive when used on any highway shall comply with the regulations hereinafter set forth, namely,—

Speed, Reasonable and Proper.—(1.) He shall not drive the light locomotive at any speed greater than is reasonable and proper, having regard to the traffic on the highway, or so as to endanger the life or limb of any person, or to the common danger of passengers.

Speed Limits.—(2.) He shall not under any circumstances drive the light locomotive at a greater speed than twelve miles an hour. If the weight unladen of the light locomotive is one ton and a half and does not exceed two tons, he shall not drive the same at a greater speed than eight miles an hour, or if such weight exceeds two tons, at a greater speed than five miles an hour.

Provided that whatever may be the weight of the light locomotive, if it is used on any highway to draw any vehicle, he shall not under any circumstances drive it at a greater speed than six miles an hour.

Provided also that this regulation shall only have effect during six months from the date of this Order, and thereafter until we otherwise direct.

Travelling Backwards.—(3.) He shall not cause the light locomotive to travel backwards for a greater distance or time than may be requisite for purposes of safety.

(4.) He shall not negligently or wilfully cause any hurt or damage to any person, carriage, horse, or cattle, or to any goods conveyed in any carriage, on any highway, or, when on the light locomotive, be in such a position that he cannot have control over the same, or quit the light locomotive without having taken due precautions against it being started in his absence, or allow the light locomotive or a vehicle drawn thereby to stand on such highway so as to cause any unnecessary obstruction thereof.

(5.) He shall when meeting any carriage, horse, or cattle keep the light locomotive on the left or near side of the road, and when passing any carriage, horse, or cattle proceeding in the same direction keep the light locomotive on the right or off side of the same.

(6.) He shall not negligently or wilfully prevent, hinder, or interrupt the free passage of any person, carriage, horse, or cattle on the highway, and shall keep the light locomotive and any vehicle drawn thereby on the left or near side of the road for the purpose of allowing such passage.

(7.) He shall, whenever necessary, by sounding the bell or other instrument required by Section 3 of the Act, give audible and sufficient warning of the approach or position of the light locomotive.

(8.) He shall on the request of any police constable, or of any person having charge of a restive horse, or on any such constable or person putting up his hand as a signal for that purpose, cause the light locomotive to stop and to remain stationary so long as may be reasonably necessary.

ARTICLE V.—If the light locomotive is one to which Regulation (6) of Article II. applies, and the particulars required by that regulation are not duly painted thereon, or if the light locomotive is one to which that regulation does not apply, the person driving or in charge thereof shall, on the request of any constable, or on the reasonable request of any other person, truly state his name and place of abode, and the name of the owner, and the place of his abode or business.

This Order may be cited as 'The Light Locomotives on Highways Order, 1896.'

Given under the seal of office of the Local Government Board, this ninth day of November, in the year one thousand eight hundred and ninety-six.

(L.S.)

HENRY CHAPLIN,
President.

HUGH OWEN,
Secretary.

THE REGULATIONS AFFECTING PETROLEUM SPIRIT

It may be useful to note that the spirit '680 specific gravity distilled from petroleum is called by Messrs. Carless, Capel and Leonard 'Petrol'; by the Anglo-American Oil Company, 'Pratt's Motor Spirit'; and by the Bowring Petroleum Co. Ltd., 'Motor Spirit.'

On account of its highly inflammable nature the railway companies have classed petroleum spirit under the third class in the general classification of railway rates. If less than one ton gross (equal 240 gallons) is sent in one consignment, in order to secure its being charged at the third-class rate, it

must be packed in separate cans enclosed in cases, and the minimum charge for its carriage is 5s. For that amount there can be sent, however :—

14 cases=	84	gallons.	(If the rate does not exceed)	10s.	per ton
7	..	42	20s. "
4	..	24	30s. "
3	..	18	40s. "

and so on, according to the rate and quantity sent.

To put this in another way, for the minimum charge of 5s. there can be sent approximately, ten cases or sixty gallons, to any place within about twenty-five miles from London, thus the cost of carriage to such places will be about a penny a gallon.

To places about fifty miles from London there can be sent about seven cases at a cost of three-halfpence a gallon.

In the same way the cost of sending to places about one hundred miles from London will be about twopence-halfpenny a gallon, and so on, according to distance.

There is, as a rule, a saving of about one-third in the relative cost of carriage if as much as a ton (equal 240 gallons) can be forwarded at one time. This is because the regulations allow that quantity to be sent in drums not enclosed in cases, and consequently the dead weight of the packages is much less in proportion to the quantity of spirit sent. There is no economy, however, in ordering a large quantity at a time unless the petrol can be stored in a suitable place.

The following regulations were issued by the Home Office on the 26th of April, 1900 :—

Locomotives on Highways Act, 1896
(59 & 60 Vict., c. 36, s. 5)

In promulgating the following regulations relating to the keeping, conveyance, and use of petroleum in connection with light locomotives, the Secretary of State for the Home Department desires to direct public attention to the dangers that may arise from the careless use of the more volatile descriptions of petroleum commonly known as petroleum spirit.

Not only is the vapour therefrom, which is given off at ordinary temperatures, capable of being easily ignited, but it is also capable, when mixed with air, of forming an explosive atmosphere. It is, therefore, necessary, in dealing with and handling the spirit, to take strict precautions by the employment of thoroughly sound and properly closed vessels, and by avoiding the use of naked lights in dangerous proximity, to prevent leakage of the spirit and the contact of any form of artificial light with the highly inflammable vapour which it is always evolving.

By virtue of the powers conferred on me by the fifth section of the Locomotives on Highways Act, 1896, I hereby make the following regulations for the keeping and use of petroleum for the purposes of light locomotives.

Save as herein provided, the provisions of the Petroleum Acts shall apply to all petroleum kept or used or sold for the purposes of light locomotives.

In these regulations the expression 'petroleum spirit' shall mean the petroleum to which the Petroleum Act, 1871, applies, provided that when any petroleum other than that to which the Petroleum Act, 1871, applies, is on or in any light locomotive or is being conveyed or kept in any place on or in which there is also present any petroleum spirit as above defined, the whole of such petroleum shall be deemed to be petroleum spirit.

In these regulations the expression 'storehouse' shall mean any room, building, coach-house, lean-to, or other place in which petroleum spirit for the purposes of light locomotives is kept in pursuance of these Regulations.

1. These regulations shall apply only to petroleum spirit which is kept for the purpose of or is being used on light locomotives, and shall not apply to petroleum spirit which is kept for sale, or partly for sale and partly for the purposes of light locomotives.

2. Petroleum spirit shall not be kept, used, or conveyed except in metal vessels so substantially constructed as not to be liable, except under circumstances of gross negligence or extraordinary accident, to be broken or become defective or insecure. Every such vessel shall be so constructed and maintained that no leakage, whether of liquid or vapour, can take place therefrom.

3. Every such vessel, not forming part of a light locomotive, when used for conveying or keeping petroleum spirit shall bear the words 'Petroleum spirit—highly inflammable' legibly and indelibly stamped or marked thereon, or on a metallic or enamelled label attached thereto, and shall be of a capacity not exceeding two gallons.

4. Before repairs are done to any such vessel, that vessel shall, as far as practicable, be cleaned by the removal of all petroleum spirit and of all dangerous vapours derived from the same.

5. Where a storehouse forms part of, or is attached to, another building, and where the intervening floor or partition is of an unsubstantial or highly inflammable character, or has an opening therein, the whole of such building shall be deemed to be the storehouse, and no portion of such storehouse shall be used as a dwelling or as a place where persons assemble. A storehouse shall have a separate entrance from the open air distinct from that of any dwelling or building in which persons assemble.

6. Every storehouse shall be thoroughly ventilated.

7. The amount of petroleum spirit to be kept in any one storehouse, whether or not upon light locomotives, shall not exceed sixty gallons at any one time.

8. Where two or more storehouses are in the same occupation and are situated within 20 feet of one another, they shall for the purposes of these regulations be assumed to be one and the same storehouse, and the maximum amount of petroleum spirit prescribed in the foregoing regulation shall be the maximum to be kept in all such storehouses taken together. Where two or more storehouses in the same occupation are distant more than 20 feet from one another the maximum amount shall apply to each storehouse.

9. Any person who keeps petroleum spirit in a storehouse which is situated within 20 feet of any other building whether or not in his occupation, or of any timber stack or other inflammable goods not owned by him, shall give notice to the local authority under the Petroleum Acts for the district in which he is keeping such petroleum spirit, that he is so keeping petroleum spirit, and shall renew such notice in the month of January in each year during the continuance of such keeping, and shall permit any duly authorised officer of the local authority to inspect such petroleum spirit at any reasonable time. This regulation shall not apply to petroleum spirit kept under licence, nor to petroleum spirit kept in a tank forming part of a light locomotive.

10. The filling or replenishing of a vessel with petroleum spirit shall not be carried on, nor shall the contents of any such vessel be exposed in the presence of fire or artificial light except a light of such construction, position, or character, as not to be liable to ignite any inflammable vapour arising from such spirit, and no artificial light shall be brought within dangerous proximity of the place where any vessel containing petroleum spirit is being kept.

11. In the case of all petroleum spirit kept or conveyed for the purpose of or in connection with any light locomotive, (a) all due precautions shall be taken for the prevention of accidents by fire or explosion, and for the prevention of unauthorised persons having access to any petroleum spirit kept or conveyed, and to the vessels containing or intended to contain, or having actually contained the same; and (b) every person managing or employed on or in connection with any light locomotive shall abstain from every act what-

ever which tends to cause fire or explosion, and which is not reasonably necessary, and shall prevent any other person from committing such act.

12. These regulations shall come into operation on the 15th day of May, 1900, from which date the regulations dated 3rd November, 1896, are hereby repealed.

M. W. RIDLEY.

One of Her Majesty's Principal Secretaries of State.
Whitehall, S.W., 26th April, 1900.

If any one desires to keep in store more than sixty gallons of petroleum spirit (petrol), it is necessary, unless separate storehouses are provided (see Clause 8), to take out a licence, which may be granted by the local authority under the provisions of the Petroleum Acts. If a suitable storage place is provided, the local authority will readily issue licences for any reasonable quantity on payment of a fee of 5s. annually.

GLOSSARY OF TERMS USED IN AUTOMOBILISM

FRENCH—GERMAN—ENGLISH

- Abaissement*, Erniedrigung, **depression**, **diminution**.
Abaisser, niedriger machen, **to lower**.
About, Stoss, **end**, **butt**.
Acier, Stahl, **steel**.
Acier à outils, Gerätstahl, **tool steel**.
Acier doux, weicher Stahl, **mild steel**.
Acier fondu, *acier coulé*, Gussstahl, **cast steel**.
Acier trempé, **tempered steel**.
Accélérateur, Beschleuniger, **accelerator**.
Accélérateur à levier, Hebel-, **lever accelerator**.
Accélérateur à pédale, Fuss-, **pedal accelerator**.
Accélération, Beschleunigung, **acceleration**.
Accident, *panne*, Misserpolz, **accident**.
Accouplement, Verkupplung, Wellenkupplung, **coupling**.
Accouplement (manchon d'), Muffenkupplung, **coupling box**.
Accumulateur, Accumulator, Sammler, **accumulator**.
Adhérence, Adhäsion, **adhesion**.
Admission, Einlass, Einfluss, **inlet**.
Admission (soupape d'), Säugventile, **inlet valve**.
Aiguille, Nadel, **needle**, **pricker**.
Aiguille à passer, Nadel, **bodkin**.
Aile, Flügel, **vane**, **leaf**, **wing**.
Aile d'hélice, Schraubenflügel, **blade of screw propeller**.
Ailette, Zapfen, **wing**, **flange**.
Ajutage, Düse, **nozzle**.
Alcool, Alkohol, **alcohol**.
Alésage, Nachbohren, **reaming**, **bore of a cylinder**.
Alène, Ahle, **awl**.
Aléser, ausdrehen, **to bore**.
Alésoir, Reibahle, **reamer**.
Alimentation, Speisung, **feed**, **supply**.
Alléger, erleichtern, **to thin**, **to reduce (the weight of something)**.
Alliage, Legierung, **alloy**.
Allonger, **to lengthen**.
Allumage, Zündung, **ignition**, **fring**.
électrique, elektrische, **electric**.
avance, à l', Voraus, **advance**.
retard, à l', Verzug, **retard**.
par tube, Glührohrzündung, **tube**.
raté d', **missfire**.
appareil d', Vorrichtung, **ignition apparatus**.
boîte d', Zündgehäuse, **ignition box**.
bobine d', Zündspule, **ignition coil**.
Allumeur, Zünder, **igniter**, **primer**.
régulation de l'allumateur, Verstellung der Zündung, Einstellung des Zündzeitpunkts.
Allure, Gang, **speed**, **pace**.

Amarrage, Geschwindigkeit, **lashing, fastening**.
Amiante, Asbest, **asbestos**.
Amorçage (moteur), Zündung, **priming**.
Amortisseur, Dämpfungsvorrichtung, **damper, dash-pot**.
Angle, Winkel, **angle**.
Angle droit, rechter Winkel, **right angle**.
Angle (roue d'), Kegellrad, **bevel wheel**.
Anneau, Ring, **ring, hoop**.
Anneau de chaîne, Gelenke, Kettenschlusglieder, **link**.
Anneau de chaîne de rechange, Reserve - Kettenschlusglieder, **spare link**.
Appareil, Apparat, Vorrichtung, **apparatus**.
Appareil d'alimentation, Wasserzuleitung, Zufuhr, **feed apparatus**.
Appareil de détente, Expansions-Steuerung, **expansion gear**.
Arbre, Welle, **shaft, axle-tree**.
Arbre à came, Daumenwelle, **cam-shaft**; Steuerwelle, **'kicking shaft**.
Arbre à vilebrequin à manivelles, *arbre coudé*, Kurbelwelle, **crank shaft**.
Arbre carré, Viereckigwelle, **square shaft**.
Arbre de frein, Bremswelle, **brake shaft**.
Arbre d'embrayage, Kupplungswelle, **clutch shaft**.
Arbre de relevage, Steuerwelle, **reversing shaft, half-speed shaft**.
Arbre intermédiaire, Vorgelergwelle, **intermediary shaft, counter-shaft**.
Arbre moteur, de couche, Treibwelle, **main shaft**.
Armature, Anker, **armature**.
Arrière, hinter, **astern, backward**.
Aspiration, Ansäugen, **suction, intake**.

Assemblage, Verbindung, **joint**.
Atelier, Werkstätte, **workshop, factory**.
Attelage, Bespannung, Zug, **team**.
Attelage (chaîne d'), Zugkette, **coupling chain**.
Aubes (roue à), Schaufel, **paddle-wheel**.
Avance (angle d'), Voreilwinkel, **angle of lead**.
Avant, en, Vorwärts, **ahead, forward**.
Avarie, panne, Havarie, **damage, breakdown**.
Axe, Achse, **axis, shaft**.
Axe de manivelle, Kurbelachse, **crank shaft**.
Axe ou essieu moteur, Treibachse, **driving shaft**.
Bâche, Teertuch, **tarpaulin**.
Bâche, Brunnen, **hot-well, tank**.
Bague, Stossring, **ring**.
Baïlle, Eimer, **bucket, tub, feed tank**.
Balai, Bürste, **brush**.
Balancier, Balancier, **beam**.
Bandage, bande, Radreifen, **tyre**.
Banlieue, Vorstadt, **suburbs**.
Baquet, Eimer, **bucket**.
Barillet, Pumpenstiefel, **barrel (pump), small barrel, keg**.
Basse pression, Niederdruck, **low pressure**.
Barbotage (des manivelles), **splashing in lubricating bath, in crank pit**.
Bâti, Gestell, **frame, bed plate**.
Batterie, Batterie, **battery**.
Bec, Brenner, **burner, jet**.
Béquille, Hemmenstange, **devil drag, sprag**.
Bidon, Kanne, Dose, **can (small)**.
Bielle, Kurbelstange, **connecting rod**.
Bielle de tiroir, Schieberstange, **valve-rod**.
Bille, Kugel, **ball**.
Blanc de céruse, Bleiweiss, **white lead**.

Blindage en fer, Eisenblech, iron sheeting.

Bloc, de frein, Bremsklotz, brake block.

Bobine, Spule, coil.

Bobine de résistance, Widerstandsspule, resistance coil.

Bobine de Rhumkorf, Funkeninductor, Zündspule, sparking coil.

Bois, Holz, wood, timber.

Boîte d'allumage, Zündgehäuse, burner box, ignition box.

Boîte à tiroir, Schieberkasten, slide valve chest.

Boîte à feu, Feuerung, fire box.

Borne, Drahtklemme, terminal, binding screw.

Bossel, höckerig, battered, bruised.

Rouche, Öffnung, orifice.

Bouchon, Giessstopfen, plug.

Boucle, Schleife, loop.

Boue, Schmutz, mud.

Bougie d'allumage, Zündkerze, sparking plug.

Boule, Kegel, ball, knob.

Boulon, Bolzen, Schraubbolzen, bolt pin.

Boulon de fondation, Befestigungsschraube, holding down bolts.

Bout du moyeu, Nabenerde, end of the nave.

Braquement, Steuerungswinkel, steering angle, lock.

Bras, Arm, arm, crank, web.

Braser, hartlöthen, to brase.

Bride, Verbindung, flange, bridge, clip.

Broche, Spindel, Dorn, spindle, pin.

Broche, Spiess, broach, tommy.

Brouette, Schubkarren, wheelbarrow.

Bruit, Geräusch, noise.

Brûler, verbrennen, to burn.

Brûleur, Brenner, burner.

Brûleur (chalumeau de), Brenner, burner, stem.

Brûleur (lanterne de), Brennerkasten, burner box.

Brûleur (manchon de), Brennerhülse, burner mantle.

Brume, Nebel, fog, haze.

Burette, Kanne, can (large).

Burin, Meissel, cold chisel.

Buse, Wetterloch, nozzle.

Bute, Stutz, stop.

Butoir, Mitnehmer, triprod, kicker.

Câble de remorque, Bugsierseile, tow rope.

Cadran, Zifferblatt, dial.

Cadre, Rahmen, frame.

Caisse, Kasten; Wagenkasten, chest, box, case, body.

Caisse, à eau, Wassertank, water-tank.

Cale, Unterlage, wedge.

Caler, to prop, to scotch.

Calibre, gabarit, Lehre, template.

Came, Daumen, cam, tappet, lifter, kicker.

Camion, Frachtwagen, Lastwagen, heavy four-wheeled waggon, lorry, truck.

Caniveau, Rinne, the gutter formed by a roadway and the adjoining kerb.

Caoutchouc, Gummi, indiarubber.

Capote, Verdeck, hood.

Carne, Kante, edge.

Carneaux de chaudière, Feuerzugesse, boiler flues.

Carre, Quadrat, square.

Carrefour, Kreuzweg, road crossing.

Carrossage (d'une roue), Sturtz, Achsenkelsturtz, dishing of a wheel.

Carrosserie, Wagenwerk, carriage work.

Carte, Karte, map.

Carter, Gehäuse, casing, gear case, base chamber.

Cassure, Bruch, fracture.

Cendre, Asche, ash.

Cendrier, Achsenkasten, ashpit.

Cercle primitif, Theilkreis, pitch circle.

Céruse, Bleiweiss, white lead.

- Chaîne à la Vaucanson*, Vaucanson'sche Kette, **pitch-chain**.
Chaîne à rouleaux, Rollenkette, **roller chain**.
Chalumeau, Löthrohr, **blowpipe**.
Chambre des manivelles, **crank-chamber**.
Changement de marche, Umsteuerung, **reversing gear**.
Changement de vitesse, Geschwindigkeitsänderung, Wechselgetriebe, **change of speed**.
Chapeau (palier), Kappe, Deckel, (Lager), **cap piece, bearing**.
Chapeau de moyeu, Achsenkappe, **axle cap**.
Charbon, Kohle, **charcoal or coal**.
Charge, Belastung, **load**.
Charnière, Scharnier, Hesse, **hinge, joint**.
Charpente, Zimmerwerk, **timber work or framing**.
Châssis, Untergestellt, **under-frame**.
Chaudière, *chaudronnier*, Dampfkessel, Kesselmacher, **steam boiler, boiler maker**.
Chauffage d'un essieu ou d'un coussinet, Warmlaufen einer Achse, **running hot of an axle or a bearing**.
Chausée, Kunststrasse, **highway**.
Cheminée, Schornstein, **chimney, smoke stack**.
Chemise, Kleidung, **jacket**.
Chêne, Eiche, **oak**.
Cheville, Schlussnagel, **pin, peg, bolt, plug**.
Cheville ouverte, Reihnagel, **fore-pin, of fifth wheel of a carriage**.
Chicane, baffle plate.
Cintré, gebogen, **bent**.
Circulation (pompe de), Druckpumpe, **circulation pump**.
Clapet, Klappventil, **valve clack**.
Clavette, Keil, **key, feather**.
Clef, Schlüssel, **spanner, monkey wrench**.
Cliquet, Sperre, **pawl**.
Coincement, Festdrückung, **wedging, jamming, binding**.
Col de cygne, Schwanenhals, **goose-neck**.
Collet, Rand, **neck, collar**.
Collier, frette, collet, Hülse, **collar**.
Collier d'excentrique, Excentrikreifen, **excentric strap**.
Collision, choc, Stoss, **impact**.
Commande, Getriebe, **transmission**.
Commutateur, Kommutator, Umschalter, **commutator, two-way switch**.
Compteur, Messapparat, **counter, meter**.
Cône, Conus, **cone, taper**.
Contact (par frottement), Reibungskontakt, **rubbing contact**.
Contre-écrou, Gegenmutter, **lock nut, check nut**.
Contre-poids, Gegengewicht, **counterweight, balance weight**.
Coquille, Schale, **shell**.
Cordage, Corde, Strick, **rope**.
Cornière, Winkeleisen, **angle iron**.
Côté, Seite, **side**.
Coude, Krummer, **elbow**.
Coulisse, Falz, **channel or groove**.
Coulisse de Stephenson, Stephenson'sche Coulissensteuerung, **Stephenson's link motion**.
Coulisseau, Gleitbacken, **slideblock, crosshead**.
Couper, schneiden, **to cut**.
Couple, Drehmoment, **torque, coupling chain**.
Courant, Strom, **current**.
Courbé, gebogen, **bent**.
Couronne, Kettenrad, **sprocket wheel**.
Courroie, Riemen, **belt, strap**.
Course, Fernfahrt, **race**.
Course de piston, Kolbenhub, **piston stroke**.
Court circuit, Kurzschluss, **short circuit**.
Coussinet, Lager, **bush-bearing**.
Couvre-joint, Stossfuge, **butt joint**.
Cracher, electric mach., **to spark**

(brushes); gas engines, to fire back.
Crémaillère, Zahnstange, rack.
Creux, Höhlung, hollow, depth.
Cric, Wagenwinde, jack.
Cuir, Leder, leather.
Cuivre, Kupfer, copper.
Culasse, Cylinderdeckel, cylinder-cover.
Culotte d'admission, induction valve cover or chamber.
Courseur, Läufer, index, slide-block.
Curve, Finner, tub.
Cycle, Kreisprozess, cycle.
Cylindre, Cylinder, cylinder.

Débrayage, Ausrückvorrichtung, disengaging gear.
Décharge, Entladung, discharge.
Déchet, Schwinden, waste, loss.
Déclat, Auslösungsvorrichtung, Slipphaken, Drücker, trip gear, catch, trigger.
Découper, Durchschlagen, to punch.
Décrochage d'attelage, Ausrücken der Kuppelung, disconnecting, disengaging, throwing out of gear.
Dedans (en), innerhalb, inside, within.
Dégagement de vapeur, Dampfentwicklung, production of steam.
Dégauchi (-ie), vollkommen, straight, flush.
Dehors, ausserhalb, out, outside.
Démarrage, Anlassen, start.
Dent, hélicoïde, Zahn eines Schraubengetriebes, tooth of a spiral wheel.
Dent, Radzahn, tooth.
Dépense d'entretien, Beköstigung, Unterhaltungskosten, expense of maintenance.
Dérápé, Schlüpfung, side slip.
Dérayer, ein Rad aushemmen, take the brake off a wheel.
Désembrayer, ausrücken, entkup-

peln, to disengage, to disconnect.
Dessous, unter, under, below.
Dessus, über, over, above.
Détente, Expansion, expansion.
Differential, Differentialgetriebe, jack-in-the-box, balance gear.
Direction, Steuergerät, steering gear.
Dispositif, Vorrichtung, arrangement, device.
Distance, Entfernung, distance.
Dos, Rücken, back.
Doucement, langsam, slowly.
Douille, Tülle, Hülse, socket.
Droit, recht, right.
Durée, Dauer, Fortdauer, duration.
Dynamomètre à ressort, Federdynamometer, spring dynamometer.

Eau d'injection, Einspritzwasser, injection water.
Ebullition (point d), Siedepunkt, boiling-point.
Ecartement des essieux, Empattement, Entfernung der Achsen, wheel-base.
Echappement, Auspuff, exhaust.
Echarpe, Blattung, scarf joint.
Echelle, Leiter, ladder, scale.
Eclairage, Beleuchtung, illumination.
Eclisse, Lasche, Stossplatte, fish-plate.
Ecran, Schirm, screen.
Ecrou, Mutter, nut.
Ecuage (des roues), Ecuanteur, dish (of the wheels).
Effort de traction, Zugkraft, draw-bar pull.
Elaucé, schlank, thin, slender.
Elever, errichten, to erect, to raise.
Email, Schmelzglas, enamel.
Emballer, wettauflaufen, to race.
Emballage (de roue), beschienen, tyreing.
Emboiture du moyeu, Nabenloch, axle-box.

- Embouchure*, Mündung, **mouth**.
Embrayer, einkuppeln, to throw in gear.
Embrumé, neblig, foggy, misty, hazy.
Empattement, Radlinie, wheel base.
Enclanchement, Eindrucker, locking gear.
Encliquetage, Gesperre, Sperrvorrichtung, pawl and ratchet gear.
Encoche, Aussparung, notch.
Engorgement, Verstopfung, obstruction.
Engrenage conique, Kegel-Getriebe, bevel gear.
Engrenage droit, Stirnrad-Getriebe, spur wheel.
Engrenage, Zahnräder, toothed gearing, cog wheels.
Enrayer, hemmen, to stop, to trig, to skid, to scotch (a wheel).
Entaille, Schieberloch, notch.
Entrefer, Luftraum, air gap.
Entretien, Unterhaltung, maintenance.
Entretoise de châssis, Quersprosse, Querbalk, cross-bar, cross-beam.
Enveloppe, Bekleidung, jacket, casing.
Epaisseur, Stärke, thickness, dimension.
Epissure, Splicing, splice.
Epontille, Stütze, stanchion.
Epreuve, Probe, trial proof, test.
Escarbilles, Asche, ashes, cinders.
Escarondelle, Achsnagel, pin, forelock.
Esprit, Spiritus, spirit.
Essai, Probe, trial, experiment.
Essence, Essenz, essence, spirit.
Essieu, Achse, Welle, axle.
Essieu d'arrière, Hinterachse, hind axle, rear axle.
Essieu d'avant, Vorderachse, fore axle.
Estampille, Fabrikstempel, trademark.
- Estoquian*, Sperrklinke, Drücker, pawl.
Etain, Zinn, tin.
Etalon, Normalmass, standard.
Etalonner, aichen, to standardise.
Etanche, dicht, tight.
Etape, tägliche Fahrt, stage.
Etau, Schraubstock, vice.
Etincelle, Funken, spark.
Etroit, schmal, narrow.
Evider, auskehlen, to groove.
- Fabricant*, Fabrikant, manufacturer.
Fanal, Laterne, lantern.
Fardier, offene Güterwagen, Lastwagen, truck, goods lorry.
À Faux, falsch, verkehrt, not properly, the wrong way.
Fente, Spalte, fissure.
Fer, Eisen, iron.
Fer à angle, Winkeleisen, angle iron.
Fer à cheval, Hufeisen, horse-shoe.
Fer à T, T-Eisen, T iron.
Fer feuillard, Bandeisen, hoop iron.
Fer fondu, Gusseisen, cast iron.
Fil, Draht, wire.
Filet de vis, Schraubengewinde, thread, worm of a screw.
Filière, Schneidkluppen, die, screw plate.
Flasque, Seitenstück, flitch plate.
Flotteur, Schwimmer, float.
Fonte, Gussstück, casting.
Force centrifuge, Zentrifugalkraft, centrifugal force.
Force de traction, Zugkraft, traction, tractive force.
Force d'un ressort, Tragfähigkeit einer Feder, strength of a spring.
Foret, Bohrer, drill.
Fourche, Gabel, fork.
Fourgon, Packwagen, baggage wagon.
Fournaise, Ofen, furnace.
Fourneau d'une chaudière, Kessel-feruerung, furnace of a boiler.

Fourreau compensateur, Dehnungsstopfbüchse, **expansion joint**.
Fouurrure, Futterung, **fish, lining**.
Foyer, Feuerkasten, **fire box**.
Frais de camionnage, Rollgebühren, **portage, cartage**.
Frais d'entretien, Unterhaltungskosten, **expenses of maintenance**.
Fraise, Fräse, **milling cutter**.
Fraiser, versenken, **to countersink**.
Frein, Bremse, **brake**.
Frein différentiel, automatische selbstthätige Bremse, **act-brake on differential**.
Frêne, Esche, **ash (wood)**.
Frette, Nabering, Reifen, **nave-hoop, shrunk collar**.
Frette de moyen, Äusserenabering, **nave-hoop**.
Fringalage, Schlüpfung, **side slip**.
Frottement, Reibung, **friction**.
Frottement de roulement, rollende Reibung, **rolling friction**.
Fumée, Rauch, **smoke**.
Fuseau, Spindel, **spindle**.
Fusée, Achsschenkel, **axle-journal**.

Gabarit, Calibre, Schablone, **template**.
Galet, Rolle, **friction roller, pulley**.
Galopin, Handwagen, **hand-truck**.
Garde-crotte, Spritzrahmen, **splash board**.
Garde (plaque de), Schutzplatte, **horn plate**.
Gare, Station, **station**.
Garniture, étoupe, Packung, **packing (for glands)**.
Garniture métallique, Metallpackung, **metallic packing**.
Genouillère, Kugelscharnier, **ball and socket joint**.
Glissement, Gleiten, Schlüpfung, **sliding, slipping**.
Gorge, Kehle, **throat**.
Gorge d'essieu, Achsenhals, **bearing neck of an axle or shaft**.

Goujon, Kupplungsbolzen, **coupling-bolt**.
Goupille, Bolzen, Stift, **pin, cotter**.
Goupiller, annageln, **to pin**.
Goutte, Tropfen, **drop**.
Goutte à goutte, tropfenweise, **drop by drop**.
Grain de butée, de crapaudine, Zapfenlagerpfanne, **Stutzpfanne, thrust plate of a step bearing**.
Graisser, schmelzen, **to oil**.
Graisseur, Schmiervorrichtung, **lubricator**.
Graisseur compte-gouttes, graisseur à gouttes visibles, **sight feed lubricator**.
Grêle, Hagel, **hail**.
Griffe (manchon à), Klaue, Kuppelung, **clutch**.
Grille, Gitterwerk, **grate, grating**.
Grippage, heislaufen das Lager, **seising (bearings)**.
Grue, Kran, **crane**.
Guide, Führung, **guides**.
Guipage, Überspinnung, **braiding, taping**.

Haie, Hecke, **hedge**.
Halage, Bugsieren, **towing, hauling**.
Halte, Haltepunkt, **station, stop**.
Haute pression, Hochdruck, **high pressure**.
Hélice, Schraube, **screw**.
Houille, Schwarzkohle, **coal**.
Huile, Öl, **oil**.
Huileur, syn. *graisseur*.

Ignition, Entzündung, **ignition**.
Imperméable, wasserdicht, **water-proof**.
Inclinaison, Steigungsverhältnis, **slope, gradient**.
Incrustation, Kesselstein, **boiler scales**.
Indicateur de niveau d'eau, Wasserstandszeiger an Dampfkesseln, **Schauglas, water gauge**.

Inducteur, Induktor, **inductor**.
Induit, Anker, **armature**.
Inertie, Trägheit, **inertia**.
Ingenieur, Ingenieur, **engineer**.
Injection, Einspritzung, **injection**.
Intensité, Stromstärke, **intensity** (current).
Interrupteur, Commutateur, Ausschalter, **switch**.
Inversion, Umkehrung, **reversal**.

Jante de roue, Felge, **felloe**, rim.
Jauge, Eichmass, Lehre, **gauge**.
Jet, jet.
Jeu des dents, Spielraum, **backlash** (in gearing).
Joint à la Cardan, Universalgelenk, Cardan, cardan'sche Gelenke, double knuckle, or **universal joint**.
Joint, Fuge, Verbindung, Gelenke, **joint**, link.
Joue, jumelle, Wangen, **cheek**, flange.

Lâcher, nachlassen, **to slacken**, let go.
Laisser, lassen, **to let**.
Laiton, Messing, **brass**.
Lame, Klinge, **blade**.
Lame d'eau dans les chaudières, Wasserwände, **water spaces** in boilers.
Lame de plomb, das Bleiblech, **lead-plate**.
Languelette, Scheerzapfen, **feather**, tongue.
Léger, leicht, **light**.
Lest, Ballast, **ballast**.
Levier, Hebel, **lever**.
Levier de changement de marche, Umsteuerungshebel, **reversing gear**, **reversing lever**.
Lien, Band, tie, **strap**.
Ligature, Wickelbund, **binding joint**.
Lignite, Braunkohle, **brown-coal**, lignite.
Lime, Feile, **file**.

Limon, Schlamm, **mud**, **slime**.
Linguet, Sperre, **pawl**.
Lisse, glatt, **smooth**.
Locomotive routière, Strassenlokomotive, **road locomotive**, **road engine**, **traction engine**.
Longrine, longeron, Langschwelle, **longitudinal**, **frame plate**, or **sleepers**.
Longueur, Länge, **length**.
Longueur de course, Länge des Hubs, **length of stroke**.
Lourd temps, nebliges Wetter, **muggy**, **dull weather**.
Lumière, Licht, Loch, **light**, hole, **port**.
Lunette, Protzloch, **pintle-hole**.
Lunettes de chauffeur, Staubbrille, **goggles**.

Macadam, Kieselschlag, **macadam**.
Mâchefer, Herdschlacke, **clinker**, **slag**.
Machine à tailler les roues, Räderschneidmaschine, **gear-cutting machine**.
Machine à vapeur, Dampfmaschine, **steam engine**.
Madrier, Bohle, **thick board** or **plank**.
Maillechort, Neusilber, **German silver**.
Maillon, Kettenglied, **link of a chain**.
Maniabilité, Lenksamkeit, Handlichkeit, **ease of management**.
Manomètre, Dampfdruckmesser, **steam gauge**, **water gauge**, &c.
Manche, Heft, **handle**.
Manchon d'accouplement, Kupplungsmuffe, **coupling box**.
Manchon (de brûleur), Brennerhülse, **burner mantle**.
Manchon d'embrayage et de désembrayage, Kupplung zum Ein- und Ausrücken, **clutch-coupling**.
Manchon mobile (régulateur), **sliding sleeve** (governor's).

Manette, Handhabe, **handle**, **lever**.

Manille, Schäkel, **shackle**.

Manivelle, Kurbel, **crank**.

Manivelle, Schlüsseskurbel, **spanner**, **handle**.

Manivelle composée, mehrfache Doppelkurbel, **double crank**.

Manivelle de mise en marche, Anlassungskurbel, **starting handle**.

Marchepied, Stufe, **step**.

Marteau, Hammer, **hammer**.

Marteau à river, Döppel, **riveting hammer**.

Marteau de régulateur, Regulatorhammer, **governor hammer**.

Mastic, Kitt, **putty**, **cement**.

Matage, Stauchen, **upsetting**.

Matériel roulant, das rollende Material, **rolling stock**.

Mécanicien, Maschinenwärter, **mechanic**, **engine-driver**.

Mécanique d'enrayage, Schraubenbremse, **skidding gear**, **screw-brake**.

Mèche, Docht, **wick**.

Mèche (foret), Beißel, **boring bit**.

Mélange, Mischung, **mixture**.

Mentonnet, Daumen, **cam**.

Mettre en exploitation, in Betrieb setzen, **to set at work**, **to work**.

Mettre en mouvement, Maschine anlassen, **to start the engine**.

Mise en train, en marche, en route, Anlassgetriebe, **starting gear**.

Mise en train automatique, automatische Anlassvorrichtung, **self-starter**.

Montée d'une route, Steigung einer Strasse, **gradient of a road**.

Morillon, Schliessblech, **hasp**, **cotter**.

Mouton de voiture, Docken, **coach standard**.

Mouvement accéléré, beschleunigte Bewegung, **increased motion**.

Moyeu, Hülse, **hub**.

Moyeu d'un volant, Hülse, **nave (of a fly wheel)**.

Neige, Schnee, **snow**.

Nervure, Rippe, **rib**.

Niveau, Horizont, **level**.

Nœud, Knotenschlag, **knot**, **hitch**.

Noix (à griffes), Griff, Klaue, **toothed clutch**.

Noyau, boisseau, Hahnkegel, **plug of a cock**.

Noyau, Kern, **core (foundry)**.

Noyer un clou, Nagel versenken, **to countersink**.

Nuage, Wolke, **cloud**.

Obstacle, das Hindernis, Widerstand, **impediment**.

Œil d'un boulon, Auge, **eye of a bolt**.

Omnibus, der Omnibuswagen, **omnibus**.

Onde, Welle, **wave**.

Organe, Vorrichtung, Theil, **part**.

Organeau, Ring, **ring**.

Orifice, Öffnung, **orifice**, **nozzle**.

Orifice d'évacuation, Dampfaustrittskanal, Auspuffskanal, **exhaust port**.

Ornière, Gleis, Radspur, **rut**, **groove**.

Outillage, Einrichtung, **plant**, **tools**.

Palan, Zugwinde, **tackle (lifting)**.

Palier, horizontale Strecke, Lager, **level**, **bearing**.

Palier à billes, Kugellager, **ball bearings**.

Palier à rouleaux, Wellenlager, **roller bearing**.

Palonnier, Schwenkel eines Wagens, **swing bar**.

Panne, Unfall, **accident**, **break-down**.

Pannetons, Backen, **clamps**.

Paroi, Wand, **partition**.

Pas, Schraubengang, Theilung, **pitch**.

Passage, Strassenübergang, **crossing**.

Patin, Gleitbacken bei der Steuerkulissee, **sliding-block**.

Patinage, Schleifen, Schlüpfung, **slipping on greasy ground or rails**.

Patte, Flügel, lug, **hasp, bracket, fastening, ear**.

Pave, Steinpflaster, **pavement**.

Pédale, Pedal, Trittbrett, **treadle**.

Pelle à coke, Kohlenschaufel, **fire-shovel**.

Pencher, anlehnen, **to incline**.

Pente, Neigung, **slope, declivity**.

Pentures, Aufhängungsbeschlag, **hinges**.

Perré, Sickergraben, **ditch**.

Pesé, Gewicht, **weighing**.

Petit cheval, Hilfsmaschine, **donkey engine**.

Pignon, Getriebe, **pinion**.

Pile électrique, galvanische Säule, **electric battery**.

Pile sèche, Trockenelement, **dry battery**.

Pile voltaïque, galvanische Batterie, **galvanic or electric battery**.

Pince monseigneur, Brechstange, **crowbar**.

Pincés, Drathzange, **pliers, nippers**.

Piste, Hufschlag (in der Bahn), **track**.

Piste relevée, **banked track**.

Piston, Kolben, **piston**.

Plancher, Decke, Fussboden, **floor, flooring**.

Plaque de fondation, Fundamentplatte, **foundation plate, bed plate**.

Plomb, Blei, **lead**.

Poids brut, Bruttogewicht, **gross weight, dead weight**.

Poignée, Heft, Handhabe, **handle, lever**.

Point d'appui, Drehpunkt, **centre of motion, fulcrum**.

Pointeau, Spitzpunze, **centre-punch, needle (valve)**.

Pompe à feu, à incendie, Feuerspritze, **fire engine**.

Pompe d'alimentation, Speisepumpe, **feed-pump**.

Pont, Brücke, **bridge**.

Porte de foyer, Feuerthür, **fire-box door**.

Portière, Kutschenschlag, **coach door**.

Pot d'échappement, Auspufftopf, **exhaust box**.

Poteau de pente, Gradientanzeiger, **gradient post**.

Poulie, Seilrolle, **pulley**.

Poussière, Staub, **dust, grit**.

Poutre, Balken, **girder, beam**.

Prendre à la remorque, am Seile ziehen, **to take in tow**.

Presse-étoupe, Stopfbüchse, **stuffing-box**.

Pression, Druck, **pressure**.

Primage, Spucken, **priming**.

Prise de courant, Ladekontakt, **wall plug, charging plug**.

Prise de vapeur, Dampfahh, **steam valve**.

Profondeur, Tiefe, **depth**.

Robinet à trois voies, Dreiröhrhahn, **three-way cock**.

Robinet de purge, Durchblasehahn, **drain-cock, relief-cock, blow-off cock**.

Radiateur, Wasserabkühler, **water cooler, radiator**.

Rainure, Auskehlung, **gutter groove**.

Rais, rayon, Speiche, **spoke**.

Rampe, Neigung, **slope, declivity**.

Rapport, raison, Verhältnis, **ratio, rate**.

Rayon, Halbmesser, **radius**.

Rayon d'une roue, Radarm, **spoke of a wheel**.

Rechange (pièces de), Reserveteile, **spare parts**.

Réchauffeur, Vorwärmer, **feed-water heater**.

Refoulement, Compression, Druck, **back stroke, forcing stroke**.

Refroidissement, Abkühlung, **cooling**.

Registre, boiler screen.

Réglage par papillon, dtrangement,
Drosselung, **throttling.**

Remise, Remise, coach-house.

Rendement, Leistungsfähigkeit, effi-
ciency.

Renvoi du tiroir, Schiebersteuerung,
valve gear.

Réservoir, Behälter, tank.

Ressort, Feder, spring.

Ringard, Feuerhaken, poker.

Robinet, Hahn, cock, tap.

Roder (un arbre), to lap (a spindle).

Roder (une valve), einreiben, to
grind (a valve).

Rondelle, Unterlagscheibe, washer.

Roue, Rad, wheel.

Roue à chevrons, Pfeilzahnrad, Dop-
pelschaubenrad, double helical
wheel.

Roue à rochet, Sperrrad, ratchet
wheel.

Roue d'angle, Kegelrad, bevel
wheel.

Roue dentée, Zahnrad, Stirnrad, cog
wheel.

Roue hélicoïde, Schraubenrad, spiral
wheel.

Rouleau, die Walze, roller.

Route carrossable, chaussée, die Fahr-
strasse, carriage road, high-
way.

Sabot de frein, Bremsklotz, brake
block or shoe.

Saturation, Sättigung, saturation.

Scorie, Mäckefer, Schlacke, slag.

Secteur, Sektor, quadrant.

Segment de piston, Kolbenring,
piston ring.

Serre-fil, Drahthalter, connector.

Serrer le frein, bremsen, to brake.

Serrure, Schloss, lock.

Siège d'une soupape, Ventilsitz, seat
or seating of a valve.

Sifflet, Pflö, whistle.

Silencieux, Damper, silencer.

Silex, Kiesel, flint.

Socle, Fussgestell, Grundplatte,
socket, bed-plate.

Soupape, Ventil, valve.

Soupape à papillon, Drosselklappe,
throttle valve.

Soupape de sûreté, Sicherheitsventil,
safety-valve.

Soute à charbon, Kohlenbunker,
bunker.

Surchauffeur, Überhitzer, super-
heater.

Tablier, Schürze, apron.

Talus, Böschung, slope, embank-
ment.

Tambour, Trommel, drum, wide
pulley.

Tambour de frein, Bremsescheiben,
brake drum.

Tampon, Puffer, buffer; Stöpsel,
plug.

Temps beau, schönes Wetter, fine
weather.

Temps humide, feuchtes, neblig
Wetter, damp weather, wet
weather.

Tendeur, Drahtspanner, stretcher
(wire, belt).

Terrain, Erde, ground, earth.

Tige, Stange, rod, spindle.

Tirage, Zug, draught, traction.

Tirant, Zugstange, stay, tie.

Tirefond, Schraubenbolzen (für
Schienen), Spitzbolzen, coach
screw.

Tiroir, Schieber, slide-valve.

Toc, Mitnehmer, dog, catch,
driver.

Tôle, Schwarzblech, sheet-iron.

Tourillon d'essieu, Achsschenkel,
axle journal, gudgeon.

Tourillon d'une roue, Radzapfen,
spindle, pivot of a wheel.

Tourne-à-gauche, Wendeeisen, tap
wrench.

Tournevis, Schraubenzieher, screw-
driver.

Traction, Zug, traction.

Train de dessous, Untergestell,
under-carriage.

Train de dessus, Obergestell, **part of a carriage which is above the frame.**

Transmission, Übertragung, **gearing, transmission.**

Traverse, Querstück, **cross tie.**

Trémie, Rumpf, **funnel, hopper.**

Trooplein, Überfluss, **overflow.**

Trou, Loch, **hole.**

Tube, tuyau, Rohr, Schlauch, **tube, pipe.**

Tuyau de trooplein, Überflussrohr, **overflow pipe.**

Tuyauterie, Röhrenwerke, **pipng.**

Usine, Fabrik, **works.**

Usure, Abnutzung, **wear and tear.**

Utile, nutzbar, **effective, useful.**

Vaporisateur, Verdunster, **sprayer, atomiser.**

Ventilateur, Ventilator, Kapselgebläse, **fan.**

Verin, Hebelschraube, **screwjack.**

Verrou, Riegel, **bar bolt.**

Vidange, Reinigung, **blowing off.**

Vilebrequin, Drehbohrer, **hand brace. See Arbre.**

Virer, umwenden, **turn round.**

Vis, Schraube, **screw.**

Vis sans fin, Schraube, **worm.**

Vitesse, Vélocité, Geschwindigkeit, **speed, velocity.**

Voie (des voitures), Gleisbreite, **track.**

Voiture à courroie, Wagen mit Riemenbetriebe, **belt-driven car.**

Voiture à engrenages, Wagen mit Zahnradbetriebe, **gear-driven car.**

Voiture à vapeur, Dampfwagen, **steam waggon.**

Voiture de place, Droschke, **hackney.**

Voiture de remise, de louage, **carriage on hire.**

Volant, Schwungrad, **flywheel.**

Volant à main, Handrad, **hand wheel.**

ENGLISH—FRENCH—GERMAN

Acceleration, *accélération*, Beschleunigung.

Accelerator, *accélérateur*, Beschleuniger.

Accumulator, *accumulateur*, Akkumulator, Sammler.

Adhesion, adhérence, Adhäsion.

Advance, ignition, avance à l'allumage, Vorauszündung.

Ahead, forward, en avant, vorwärts.

Air gap, entrefer, Luftraum.

Alcohol, alcool, Alkohol.

Alloy, alliage, Legierung.

Apparatus, appareil, **Apparat**, Vorrichtung.

Apron, tablier, Schürze.

Armature, induit, Anker.

Arrangement (device), dispositif, Vorrichtung.

Asbestos, amiante, Asbest.

Ash (wood), frêne, Esche.

Ashes, cinders, escarbilles, cendres, Asche.

Ash pit, cendrier, Aschenkasten.

Astern, backward, en arrière, hinter.

Atomiser, see Sprayer.

Awl, alène, Ahle.

Axis, axe, Achslinie.

Axle, essieu, Achse, Welle.

Axle, fore, essieu d'avant, Vorderachse.

Axle, guard, horn plate, plaque de garde, Achsenblech.

Axle, journal or neck, fusée, tourillon d'essieu, Achsschenkel.

Axle or bearing, running hot of an, by friction, chauffage d'un essieu ou d'un coussinet, Warmlaufen einer Achse.

Axle or shaft, bearing neck of an, gorge de l'essieu, Achsenhals,

Axle, rear, *essieu d'arrière*, Hinterachse.

Axle-tree bolster, spring flap, *sellette d'essieu*, Achsschemel.

Back, *dos*, Rücken.

Backfire, *patage d'allumage*, Rückschlagen.

Backlash, *jeu des dents*, Spielraum.

Back stroke, *refoulement*, Druckhub.

Baggage waggon, fourgon, Packwagen.

Balance (spring), *dynamomètre à ressort*, Federwage.

Ball and socket joint, *genou à charnière, joint à boulet*, Kugelgelenk.

Ball bearings, *palier à billes*, Kugellager.

Ballast, *lest*, Ballast.

Banked track, *piste à virages relevés*.

Bar bolt, *verrou*, Riegel.

Battery (dry), *pile sèche*, Trockenelement.

Battery (primary), *pile*, Element (galvanisches).

Battery (secondary), *see Accumulator*.

Beam, *poutre, balancier*, Balken, Balancier.

Bearing (ball), *palier à billes, coussinet à billes*, Kugellager.

Bearing (plain), *palier (ordinaire)*, Lager.

Bearing (roller), *palier à rouleaux*, Wellenlager.

Bearing (self-oiling), *palier graisseur*, Lager mit selbstthätiger Schmierung.

Bearing (seized), *palier grippé*, Festgebunden.

Bearing (swivel), *palier à rotule*, gelenkige Lager.

Bearing (thrust), *palier de bûée*, Stutzlager.

Belt (endless strap), *courroie sans fin*, Laufriemen.

Bent, *courbé*, gebogen.

Bevel wheel, bevel gear, *roue d'angle, engrenage conique*, Kegelgetriebe.

Binding joint, *ligature*, Wickelbund.

Blade, *lame*, Klinge.

Blow-off (cock), *vidange (robinet)*, Reinigung (Hahn).

Boiler flues, *carreaux de chaudière*, Feuerzugesse.

Boiler scales, *incrustations*, Kesselstein.

Boilers, water spaces in, *lame d'eau dans les chaudières*, Wasserrände.

Boiling-point, *point d'ébullition*, Siedepunkt.

Bolt and nut, *boulon et écrou*, Schraubbolzen und Mutter.

Bolt, holding down, *boulon de fondation*, Befestigungsschraube.

Bore, alésage, Ausdrehung.

Boring, *alésage*, Nachbohren.

Boring bit, *mèche, foret*, Beißel, Bohrer.

Braiding, taping, *guipage*, Über-spinnung.

Brake, frein, Bremse.

Brake-block, or shoe, *sabot de frein*, Bremsklotz.

Brake-handle, *levier de frein*, Bremshebel.

Brake, to, freiner, serrer le frein, Bremsen.

Brake on differential, self-acting, *frein différentiel, automatique*, automatische, selbstthätige Bremse.

Brake shaft, *arbre de frein*, Bremswelle.

Brass, laiton, Messing.

Brase, to, braser, hartlöthen.

Bridge, bridge piece, pont, bride, Brücke.

Broom, balai, Bürste.

Brown-coal, lignite, Braunkohle.

Bucket, tub, baille, baquet, cuve Eimer,

Buckling, gauchissage.

Buffer, tampon, Puffer.

- Bunker**, *route à charbon*, Kohlenbunken.
- Burn**, to, *brûler*, verbrennen.
- Burner**, *candle*, *brûleur*, *bec*, *bougie*, Brenner.
- Bush-bearing**, *palier à douille*, Lager.
- Cam**, *lifter*, *came*, *mentonnet*, Daumen.
- Cam-shaft**, *arbre à came*, Daumenwelle.
- Can**, *bidon*, *burette*, Kanne, Dose.
- Cap** (*axle*), *chapeau de moyen*, Achsenkappe.
- Cap** (*bearing*), *chapeau de palier*.
- Capsie**, to, *chavirer* (*nautical*), umkippen.
- Carburettor**, *carburateur*, Vergaser.
- Carriage road**, *chaussée*, *route carrossable*, Fahrstrasse.
- Carriage work**, *carrosserie*, Wagenwerk.
- Casing**, *carter*, Gehäuse.
- Cast iron**, *fer fondu*, *fonte*, Gusseisen.
- Casting**, *fonte*, Gussstück.
- Caulking**, *calfatage*, Kalfatern.
- Cell** (*container*), *bac* (*d'accumulateur*), Gefäß.
- Cell** (*element of a battery*), *élément*, Zelle.
- Centre of motion**, *fulcrum*, *point d'appui*, Drehpunkt.
- Chain**, *coupling*, *chaîne d'attelage*.
- Chain link**, *maillon*, Kettenschlussglieder.
- Chainless**, *acaténe*, kettenlos.
- Change speed**, *changement de vitesse*, Geschwindigkeitsänderung.
- Channel or groove**, *coulisse*, *rainure*, Falz.
- Charcoal**, *charbon de bois*, Holzkohle.
- Charge**, *charge*, Ladung.
- Cheeks**, *jumelles*, *joues*, Wangen.
- Chest**, *box*, *caisse*, Kasten.
- Chimney**, *funnel*, *cheminée*, Schornstein, Rauchfang.
- Chisel**, *ciseau*, Stechbeitel, Meissel.
- Circuit-breaker**, *coupe-circuit*, Ausschalter.
- Clamps**, *pannelons*, Backen.
- Clinker**, *mâchefer*, Herdschlacke.
- Cloud**, *nuage*, Wolke.
- Clutch**, *cône de friction*, Klaue.
- Clutch**, *cône d'embrayage et de débrayage*, Kupplung.
- Coach-door**, *portière*, Kutschenschlag.
- Coach-house**, *remise*, Remise.
- Coach-screw**, *tirefond*, Schraubenbolz für Schienen, Spitzbolzen.
- Coach-standard**, *mouton de voiture*, Docken.
- Coach - wrench** (*monkey - wrench*), *shifting spanner*, *clef anglaise*, Universalschraubenschlüssel.
- Coal**, *houille*, Schwarzkohle.
- Cook**, *tap*, *robinet*, Hahn.
- Coil**, *bobine*, Spule.
- Collar**, *collier*, *frette*, *collet*, Hülse.
- Commutator** (*dynamo*), *collecteur*, Kollektor.
- Commutator** (*switch*), *commutateur*, Stromwender, Umschalter.
- Cone**, *noyau*, *cône*, Conus.
- Connecting-rod**, *bielle*, Kurbelstange.
- Connector**, *serre fil*, Drahthalter.
- Cooling**, *refroidissement*, Abkühlung.
- Copper**, *cuivre*, Kupfer.
- Cotter**, *see Pin*.
- Counter**, *meter*, *compteur*, Messapparat.
- Countersink**, to, *fraiser*, *noyer un clou*, versenken, einen Nagel versenken.
- Counter-weight**, *balance*, *contre-poids*, Gegengewicht.
- Coupling bolt**, *goujon*, Kupplungsbolzen.
- Coupling box**, *manchon d'accouplement*, Kupplungsmuffe.
- Cracked**, *fêlé*, rissig.
- Crane**, *grue*, Kran.
- Crank**, *arbre de manivelle*, Kurbel.

Crank shaft, arbre de vilebrequin,
Kurbelwelle.

Crank web, bras, Arm.

**Cross-bar, cross-beam, entre-
toise,** Quersprosse, Querbalz.

Cross-head block, slide-block,
patin, Gleitklotz.

Crossing, carrefour, Kreuzweg.

Crowbar, pince, Brechstange.

Cut, to, couper, schneiden.

Cutter, fraise, Fräse.

Cycle, cycle, Kreisprozess (mech.)

Cylinder, cylindre, cylinder.

Cylinder cover, culasse, Cylinder-
deckel.

Damage, avarie, Havarie.

Damp weather, wet weather,
temps humide, feuchtes, nasses
Wetter.

Damper, dash pot, amortisseur,
Dampfungsvorrichtung.

**Depression, diminution, abaisse-
ment,** Niedrigung.

Depth, profondeur, Tiefe.

Devil, sprag, béquille, Hemmen-
stange.

Dial, cadran, Zifferblatt.

**Differential, Jack in the box
or balance gear, différentiel,**
Differenzialgetriebe.

Discharge, décharge, Entladung.

**Disconnecting, disengaging,
throwing out of gear, dé-
brayage,** Ausrücken der Kuppel-
ung.

Disengage (to), to disconnect,
débrayer, ausrücken.

Disengaging apparatus, déclat,
Auslösungsvorrichtung. Slipp-
haken.

Disengaging gear, débrayage,
Aus- oder Entkupplung.

Dish (of a wheel), écuage, Ecuant-
teur.

Distance, distance, Entfernung.

Ditch, fossé, Sickergraben.

Donkey engine, petit cheval,
Hülfsmaschine.

**Drain-cock, relief-cock, robinet
de purge,** Durchblasehahn.

**Draught, traction, attelage,
tirage,** Bespannung, Zug.

**Drawbar pull, tractive effort,
effort de traction,** Zugkraft.

Drift punch, poinçon, Durchschlag.

Drill, foret, perceur, Bohrer.

Driver, dog, toc, Mitnehmer.

**Driving axle or shaft, axe, arbre
ou essieu moteur,** Treibachse.

**Drum (armature or wide pul-
ley), tambour,** Trommel.

Duration, durée, Dauer, Fortdauer.

Dust, grit, poussière, Staub.

**Easily, slowly, doucement, lente-
ment,** langsam.

Eccentric rod, tige d'excentrique,
Excentrikstange.

Edge, bord, arête, Kante.

Effective, useful, utile, nutzbar.

Efficiency, rendement," Leistungs-
fähigkeit.

Elbow, coude, Krummer.

Electric battery, pile électrique,
galvanische Säule, Zelle.

Enamel, émail, Schmelzglas.

End, butt, about, Stoss.

**Engine, to start the, mettre en
marche, démarrer,** Maschine
anlassen.

Erect, to, to raise, élever, errich-
ten.

**Escape of steam, dégagement de
vapeur,** Dampfentweichung.

Essence, spirit, essence, Essenz.

Exhaust-port, orifice d'évacuation,
Dampfaustrittskanal, Auspuffs-
kanal.

Expansion, expansion, Detente.

**Expansion gear, appareil de
détente, mécanisme de détente,** Ex-
pansions-Steuerung.

**Expansion joint, joint compensa-
teur,** Dehnungstopfbüchse.

**Expense of maintenance, or cost
of working, frais d'entretien,**
Unterhaltungskosten.

Eye of a bolt, *œil d'un boulon*,
Auge.

Fan, *ventilateur*, Gebläse.

Feather, *clavette noyée*, Rippe,
versenkte Keile.

Feed apparatus, *appareil d'alimen-
tation*, Zufuhr der Wasserzuleitung.

Feed-pump, *pompe d'alimentation*,
Speisepumpe.

Felly, *felloe, jante de roue*, Felge.

File, *lime*, Feile.

Fine weather, *beau temps*, schönes
Wetter.

Fire-box, *foyer, boîte à feu*, Feuer-
kasten, Feuerung.

Fire-box door, *porte de foyer*,
Feuerthür.

Fire-engine, *pompe à feu, à incendie*,
Feuerspritze.

Fire-shovel, *pelle à coke*, Kohlen-
schaufel.

Firing, *ignition, allumage*, Zündung.

Fissure, *fente*, Spalte.

Fish, lining, *sourrure*, Futterung.

Flange, *bride*, Verbindung.

Flaw, *paille, flure*, Riss.

Flint, *silex*, Kiesel.

Flitch plate, *flaque*, Seitenstock.

Float, *flotteur*, Schwimmer.

Float gauge, *indicateur à flotteur*,
Schwimmerlehre.

Flue, *carneau*, Feuercanalesse.

Fly-wheel, *volant*, Schwungrad.

Foggy, misty, hazy, *embrumé*,
neblig.

Fork, *fourche*, Gabel, Gabelstange.

Foundation plate, *base plate*,
plaque de fondation, Grundplatte.

Fracture, *cassure*, Bruch.

Frame, *cadre, châssis*, Rahmen,
Fassung, Gestell.

Frame plate, *longeron, longrine*,
Längenstück des Rahmens.

Friction, *frottement*, Reibung.

Friction (rolling), *frottement de
roulement*, rollende Reibung.

Friction roller, *pulley, galet*,
rouleau, Reibungsrolle.

Full speed, to run at, *lancer à
toute vitesse*, (einen Zug) mit voller
Geschwindigkeit ablassen.

Funnel, *entonnoir, trémie*, Rumpf.

Furnace, *fournaise, fourneau*,
Ofen.

Furnace of a boiler, *foyer d'une
chaudière*, Kesselherd.

Galvanic or electric battery,
pile voltaïque, galvanische Säule
oder Zelle.

Gauge, *gauge, jauge, calibre*, Eich-
mass, Lehre.

Gear, *engrenage, mécanisme*, Ge-
triebe.

Bevel gear, *engrenage conique*,
Kegelräder.

Spin gear, *engrenage droit*,
Stirnräder.

Worm gear, *engrenage à vis sans
fin*, Schraubenge triebe.

Gear box, *boîte à engrenages, carter*,
Zahnradergehäuse.

Gear (reversing), *marche arrière*,
Umsteuerung.

Differential, *différentiel*, Diffe-
renzialgetriebe.

Running gear, *châssis avec roues
de transmission*, Untergestellt.

Girder, beam, *poutre*, Balken.

Goggles, *lunettes de chauffeur*,
Staubbrille.

Goose-neck, *col de cygne*,
Schwanenhals.

Gradient of a road, *pente d'une
route*, Steigung eines Weges.

Gradient-post, *potiau de pente*,
Gradientanzeiger.

Grate, *grating, grille*, Gitter-
werk.

Grease, *axle-grease, graisse à
voitures*, Achsenschiere.

Groove, *rainure, creux*, Auskeh-
lung.

Groove, to, *vider*, aushohlen.

Gross weight, dead weight,
poids brut, Bruttogewicht.

Ground, earth, *terrain*, Erde.

Gudgeons, *goujon*, Ruderstevén.
Guides, *crosshead guides*, *guide*,
glissière, Führung.

Hail, *grêle*, Hagel.

Hammer, *marteau*, Hammer.

Haud-brace, *vilbrequin*, Dreh-
 bohrer.

Handle, *manette*, *manche*, *mani-
 velle*, Handhabe, Heft, Stiel.

Hasp, *morillon*, Schliessblech.

Heater (feed-water), *réchauffeur*,
 Vorwärmer.

Hedge, *haie*, Hecke.

High pressure, *haute pression*,
 Hochdruck.

Highway, *chaussée*, *route carross-
 able*, Kunststrasse.

Hinge, *charnière*, Thürband,
 Scharnier.

Hole, *orifice*, *trou*, Loch.

Hollow, *depth*, *creux*, Hohlkehle.

Hood, *capote*, Verdeck.

Hopper, *trémie*, Rumpf.

Hotwell, *baïlle (du condenseur)*,
 heisse Brunnen.

Ignition, *ignition*, *allumage*,
 Entzündung.

Impact, *collision*, *choc*, Stoss.

Impediment on the line, *obstacle
 sur la route*, Hindernis.

Inductor, *inducteur*, Induktor.

Inertia, *inertie*, Trägheit.

Injection, *injection*, Einsprit-
 zung.

Inside, *within*, *en dedans*, inner-
 halb.

Intake, *suction*, *aspiration*, *ad-
 mission*, Ansaugen.

Iron, *fer*, Eisen.

Iron, *angle*, *cornière*, *fer à angle*,
 Winkeleisen.

Iron, *hoop*, *fer feuillard*, Bandei-
 sen.

Iron, *T*, *fer à T*, T-Eisen.

Iron sheeting, *blindage en fer*,
 Eisenblech.

Jack (rack), *cric*, Wagenwinde.

Jack (screw), *verin*, Schrauben-
 winde, Hebelschraube.

Jack in the box, *différentiel*,
 Differential-Getriebe.

Jacket, *chemise*, *enveloppe*, Mantel.

Jamming, *coincement*, Festdrück-
 ung.

Jet, *jet*.

Joint, *articulation*, Fuge, Gelenke.

Joint, *joint*, *assemblage*, Ver-
 bindung.

Joint, *butt*, *couvrejoint*, Stossfuge.

Joint, *seam*, *rapport*, Naht.

Joint (universal) or *swivel
 joint*, *joint universel*, *joint à la
 Cardan*, Cardan'sche Gelenke.

Key of a lock, *clef*, Schlüssel.

Key or *feather*, *clavette*, Kiel.

Key, *wedge*, *cale*, Unterlage.

Knot, *nœud*, Knoten, Schlag.

Knuckle (double), *joint universel*,
cardan, Universalgelenke.

Ladder, *échelle*, Leiter.

Lantern, *fanal*, *lanterne*, Laterne.

Lashing, *fastening*, *amarrage*,
 Zurrung.

Lead, *plomb*, Blei.

Lead, *white*, *blanc de céruse*, Blei-
 weiss.

Leather, *cuir*, Leder.

Length, *longueur*, Länge.

Level, *niveau*, *palier*, Horizont,
 ebenig.

Lever, *levier*, *manette*, Hebel.

Light, *lumière*, Licht.

Light, *empty*, *léger*, leicht.

Lighting, *ignition*, *éclairage*, *al-
 lumage*, Beleuchtung, Zündung.

Linchpin, *cotter*, *goupille*, Splint,
 Splissnagel.

Link of a chain, *maillon*, Ketten-
 glied.

Load, *charge*, Belastung.

Loading or *laden*, *chargement*,
 Belastung.

Look, *serrure*, Schloss.

Locking-ring, *bague*, Stossring.
Loop, *boucle*, Schleife.
Low pressure, *basse pression*, Niederdruck.
Lower, to, *abaisser*, niedriger machen.
Lower a road, to, *abaisser une route*, eine Strasse tieferlegen.
Lubricator, *lubricateur, graisseur*, Schmiervorrichtung.

Macadam, *macadam*, Kiesel Schlag.
Maintenance, *entretien*, Unterhaltung.
Manufacturer, *fabricant*, Fabrikant.
Mixture, *mélange*, Mischung.
Mouth, *embouchure*, Mündung.
Mud, *boue*, Schlamm.
Muggy, dull weather, *temps lourd*, nebliges Wetter.

Nail, *clou*, Nagel.
Narrow, *étroit*, schmal.
Nave, end of the, *bout du moyeu*, Nabenende.
Nave-hole, *emboiture du moyeu*, Nabenloch.
Nave-hoop, *frette de roue*, Aussere-nabenring.
Neck, collar, *collet*, Rand.
Needle, prickler, *aiguille, épinglette*, Nadel.
Noise, bruit, Geräusch.
Not properly, the wrong way, *à faux*, falsch.
Notch, *encoche*, Aussparung.
Nozzle, *ajutage, buse*, Duse, Wetterloch.
Nut, *écrou*, Mutter.
Nut (look), *contre-écrou*, Gegenmutter.

Obstruction, engorgement, Verstopfung.
Oil, *huile*, Öl.
Oil, to, *huiler, graisser*, schmelzen.
Omnibus, *omnibus*, Omnibuswagen.
Orifice, *bouche*, Öffnung.

Orifice, nozzle, orifice, Öffnung.
Out, outside, *dehors*, ausserhalb.
Outfit, outillage, matériel, Ausstattung.
Over, above, *dessus*, über.
Overflow, *trop-plein*, Überfluss.

Pack, to, *emballer*, verpacken.
Packing for glands, *garniture, étoupe*, Packung.
Packing, metallic, *garniture métallique*, Metallpackung.
Pad, *tampon*, Schale.
Paddle-wheel, *roue à aubes*, Schaufel.
Part, partie, organe, pièce, Theil, Vorrichtung.
Partition, *paroi, cloison*, Wand.
Paving stone, *pavé*, Pflaster.
Pawl, *estouquian, linguet*, Sperrklinke.
Pin, cotter, goupille, goujon, Stift, Bolzen.
Pin, forelook, *escarondelle, cheville ouvrière*, Achsnagel.
Pin, split, *goupille fendue*, Splint, Splissnagel.
Pin, tommy, broche, Dorn.
Pinion, *pignon*, Getriebe.
Pintle-hole, *lunette*, Protzloch.
Piston-ring, *segment de piston*, Kolbenring.
Piston-rod, cross-head of the, *crosse de piston*, Querhaupt der Kolben.
Piston stroke, *course du piston*, Kolbenhub.
Pitch, *bitume, asphalte*, Pech.
Pitch, pas d'une vis, Steigung eines Schraubenganges.
Pitch-chain, *chaîne à la Vaucanson*, Vaucanson'sche Kette.
Pitch circle, *cercle primitif*, Theilkreis.
Plant, *outillage*, Betriebsanlage.
Plate (horn), *plaque de garde*, Schutzplatte.
Plate fish, *éclisse*, Lasche, Stossplatte.

Platform, perron, estrade, plate-forme, Perron.

Pliers, nippers, pinces, Die Drahtzange.

Plug, bouchon, Pflock, Stöpf.

Plug of a cock, noyau, boisseau, Hahnkegel.

Plug, sparking, bougie d'allumage, Zündkerze.

Poker, tisonnier, fourgon, Feuerhaken.

Portage, cartage, frais de camionnage, Rollgebühren.

Pressure, pression, Druck.

Pulley, poulie, Seilrolle.

Punch, poinçon, Stämpf.

Punch, to, découper, poinçonner, Durchschlagen.

Putty, cement, mastic, Kitt.

Rack, crémaillère, Zahnstange.

Radiator, radiateur, Radiator für Abkühlung des Circulationswassers.

Radius, rayon, Halbmesser.

Railway, railroad, chemin de fer, voie ferrée, Eisenbahn.

Ratio, rate, rapport, Verhältnis.

Reamer, alésoir, Nachräumer.

Rear or hind part, arrière-corps, Hinterflügel.

Resistance coil, bobine de résistance, Widerstandsspule.

Reversal, inversion, Umkehrung.

Reversing lever, reversing handle, levier de changement de marche, levier de marche en arrière, Umsteuerungshebel.

Right, droit, gerade, recht.

Ring, band, hoop, anneau, organeau, Ring.

Road locomotive, road engine, traction engine, locomotive routière, Strassenlokomotive.

Rod, tige, Stange.

Roller, galet, rouleau, Walze.

Rolling stock, matériel roulant, rollendes Material.

Rope, cable, cordage, corde, Seil, Tau.

Running hot of an axle or a

bearing by friction, seising, chauffage d'un essieu ou d'un coussinet, Warmlaufen einer Achse.

Rut, groove, ornière, Radspur, Gleiss.

Safety valve, soupape de sûreté, Sicherheitsventil.

Saturation, saturation, Sättigung.

Scale (boiler), incrustation, Kesselstein.

Scarf, joint, écharpe, Blattung.

Screen, écran, registre, Schirm.

Screw, hélice, vis, Schraube.

Screw, worm of a, thread, filet de vis, pas de vis, Schraubengewinde.

Screwbolt, boulon fileté, Schraubenbolzen.

Screw-jack, vérin, Hebelschraube, Wagenwinde.

Seising (bearings), grippage (paliers, tourillons), Heisslaufen (Lager oder Schalen- und Zapfen).

Shackle, manille, Schäkel.

Shaft, axle-tree, arbre, Welle.

Sheet-iron, tôle, Schwarzblech.

Short (circuit), court circuit, Kurzschluss.

Side, côté, Seite.

Silencer, silencieux, Dämpfer.

Silver (German), maillechort, Neusilber.

Skidding, or scotching a wheel, enrayage, Hemmung.

Slacken, to, lâcher, ralentir, nachlassen.

Slide valve, tiroir, Schieber.

Slide valve chest, boîte à tiroir, Schieberkasten.

Sliding block, patin, Gleitbacken.

Slipping, side slip, dérapage, patinage, Schlüpfung, Schlüpfbarkeit.

Slope, declivity, pente, Hang, Neigung.

Slope, embankment, talus, Böschung.

Sloping, inclining, penchant, incliné, abhängig.

Smoke, fumée, Rauch.
Smooth, lisse, glatt.
Snow, neige, Schnee.
Socket, douille, Tülle, Hülse.
Spanner, clef, Schlüssel.
Spark, étincelle, Funken.
Speed, pace, allure, Gang.
Speed lever, levier de changement de vitesse, Schnelligkeithebel.
Spindle, broche, fuseau, Spindel.
Spindle, pivot of a wheel, tourillon d'une roue, Radzapfen.
Spirit, esprit, Spiritus.
Splash board, garde-crotte, Spritzrahmen.
Splice, épissure, Splissung.
Spoke, rais, Speiche; rayon d'une roue, Radarm.
Sprayer, atomiser, vaporisateur, Verdunster.
Spring, ressort, Feder.
Spring, strength of a, force d'un ressort, Tragfähigkeit einer Feder.
Spring-balance, pèse à ressort, Federwage.
Sprocket-wheel, couronne, roue à chaîne, Kettenrad.
Spur-wheel, engrenage, droit, Stirnradgetriebe.
Square, carré, Quadrat.
Stage, étape, tägliche Fahrt.
Stanchion, épontille, Stütze.
Standard, étalon, Normalmass.
Starting, démarrage, in Gangsetzung, anlassen.
Starting gear, mise en train, mise en marche, Anlassgetriebe.
Station, gare, halte, die Station, Haltestelle, Bahnhof.
Steam boiler, boiler-maker, chaudière, chaudronnier, Dampfkessel, Kesselmacher.
Steam engine, machine à vapeur, Dampfmaschine.
Steam gauge, manomètre, Dampfspannungsmesser.
Steam valve, prise de vapeur, Dampfhahn.
Steam waggon, voiture à vapeur, Dampfwagen.

Steel, acier, Stahl.
Steel, cast, acier fondu, Gussstahl.
Steel, mild, acier doux, weicher Stahl.
Steering gear, direction, Steuerung, Steuergerät.
Step, marche, marche-pied, Stufe.
Stephenson's link motion, coulisse de Stephenson, Stephenson'sche Coullissensteuerung.
Stop, to, enrayer, hemmen.
Straight, flush, affleuré, vollkommen.
Strap, courroie, Riemen.
Strengthening-pieces, fourrure, contrefort, Verbandstücke.
Stretcher (belt), tendeur, Drahtspanner.
Stroke, length of, longueur de course, Länge des Hubs.
Stuffing-box, boîte à garniture, Stopfbüchse.
Stuffing-box, gland of a, presse-étoupe, Stopfbüchsendeckel.
Switch, interrupteur, commutateur, Schalter.
Take in tow, to, prendre à la remorque, am Seile ziehen.
Tank, bûche, réservoir, Behälter.
Tap, see Cock, robinet, Hahn.
Tape, ruban, Band.
Tarpaulin, bâche, Teertuch.
Templet, gabarit, calibre, Lehre.
Terminal binding screw, borne, Drahtklemme.
Thickness (dimension), épaisseur, Stärke.
Thin, slender, élancé, schlank.
Throat, gorge, Kehle.
Throttle, papillon, Drosselklappe.
Throw in gear, to, embrayer, einkuppeln.
Throw over, to, jeter par-dessus bord, über Bord werfen.
Tie, lien, Band.
Tight, étanche, dicht.
Timber, bois de construction, Holz, Bauholz.

Timber, work or framing, char-
pente, Zimmerwerk.

Tin, étain, Zinn.

Tommy, see Pin.

Tooth, dent, Radzahn.

Torque, couple, Drehmoment.

Towing, hauling, halage, Bugsie-
ren, Schleppen.

Towing line, rope, remorque,
Schepptau.

Track, piste, voie des voitures, Gleis-
breite.

Traction, tractive force, force de
traction, Zugkraft.

Trade-mark, estampille, marque de
fabrique, Fabrikstempel.

Transmission, transmission, Über-
tragung.

Tread (of a waggon), voie, Tritt,
Schritt, Laufläche eines Rades.

Trial, experiment, essai, Probe.

Trial proof, test, épreuve, Probe.

Trip gear, Trigger, détente, déclat,
Drückler, Gesperre.

Truck, goods waggon, fardier,
Lastwagen, Plateauwagen.

Tube, tube, tuyau, Rohr.

Tyre, bandage, Radreifen der Rad-
reif.

Tyre on a wheel, to put the,
embatter une roue, ein Rad be-
schlagen.

Unbolt, to, déharrer, ausriegeln.

Under, below, dessous, unter.

Under-frame, châssis, Untergestell.

Valve, soupape, Ventil.

Valve, clack, clapet, Klappe.

Valve gear, valve motion, ren-
voi de tiroir, Schiebersteuerung.

Valve (reducing), détenteur,
Expansionsschieber.

Valve-rod, tige du tiroir, Schie-
berstange.

Valve, seat or seating of a, siège
d'une soupape, Ventilsitz.

Vane, leaf, tooth, aile, Flügel.

Vice, étau, Schraubstock.

Waggon, heavy four-wheeled
lorry, camion, Frachtwagen.

Washer, rondelle, Unterlagscheibe.

Waste, loss, déchet, Schwinden.

Water gauge, indicateur de niveau
d'eau, Wasserstandszeiger an
Dampfkesseln, Pegel.

Waterproof, imperméable, wasser-
dicht.

Water-tank, réservoir à eau,
caisse à eau, bache, baille,
Wassertank.

Way, road, chemin, Weg, Strasse.

Wear and tear, usure, Abnutzung.

Wedge, coin, Keil.

Weight, pesée, poids, Gewicht.

Wheel, roue, Rad.

Wheel-base, écartement des essieux,
empattement, Entfernung der
Achsen.

Wheel-cutting engine, machine
à tailler les engrenages, Räder-
schneidmaschine.

Wheel, fore, roue de devant,
Vorderrad.

Wheel, rear, roue de derrière,
Hinterrad.

Wheels, to relieve the, décharger
les roues, Räder entlasten.

Wheelwork, toothed; cog-
wheels, engrenage, roue dentée,
Zahnradwerk.

Whistle, sifflet, Pöfe.

Wick, mèche, Docht.

Wing, flange, ailette, Zapfen.

Wire, fil, Draht.

Wood, timber, bois, Holz.

Work, at, en activité, im Betriebe.

Works, usine, Fabrik.

Workshop, factory, atelier,
Atelier, Fabrik.

Yoke, culasse (dynamo), Yoch.

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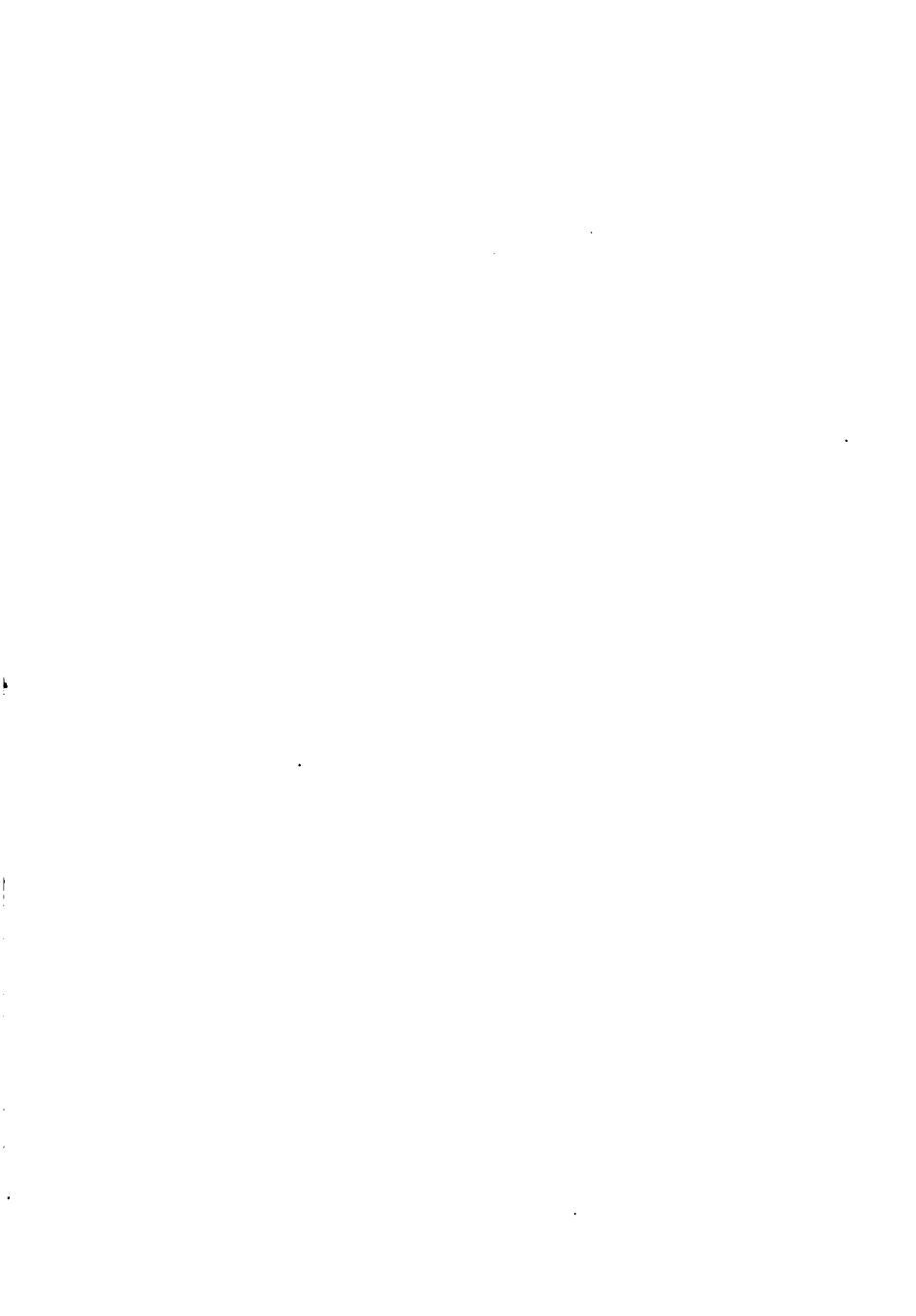
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